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(Incorporating *Research and Industry*)

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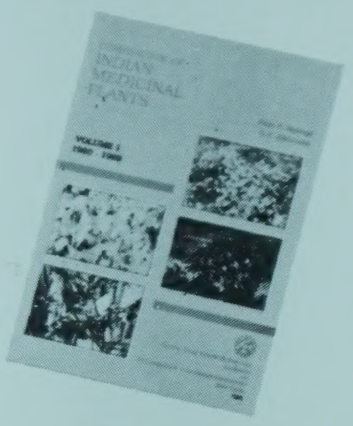
Compendium of Indian Medicinal Plants



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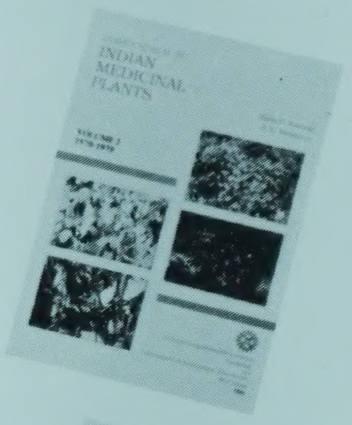
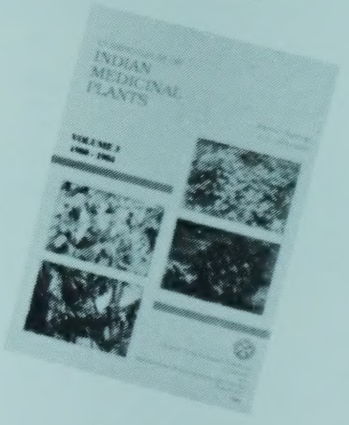
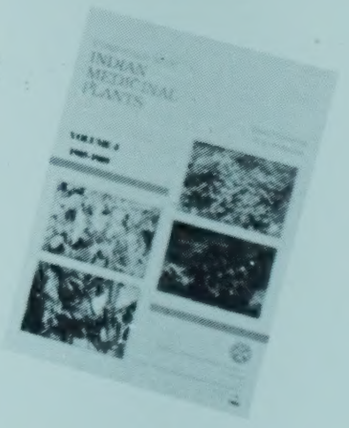


The volumes provide information on all the compounds obtained from Indian plants that have medicinal properties. Chemical structures of these compounds break the monotony of the text. The isolation of these compounds from the plants and the description of their biological activities boost the usefulness of the compendium. The names of plants, families and orders of plants have been updated. Additional information in the volumes appears in the form of three indexes comprising local names, chemical constituents and biological activities. The first volume describes almost 1200 plants covering the ten year period 1960-69. The second volume covers the period 1970-79 and describes 1684 plants. The third volume covers the period 1980-84 and describes 1600 plants. The fourth volume covers the period 1985-89 and describes 1650 plants. The volumes include research done all over the world on medicinal plants found in India, whether indigenous or introduced. The volumes are useful for botanists, chemists and all those working on medicinal plants/natural products.





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Phone: 5746024 Telex: 031-77271 PID IN Fax: (0091)-11-5787062
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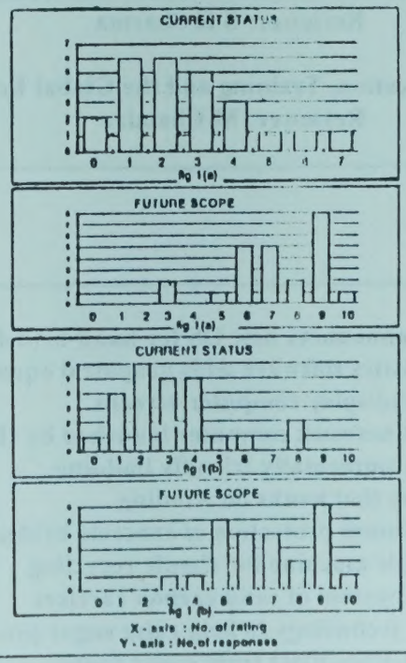

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INDIAN SCIENCE CONGRESS 1997

Frontiers in Science and Engineering and Their Relevance to National Development*

S K Joshi

National Physical Laboratory, New Delhi 110 012, India

Introduction

Twentieth century is edging to its end and we are preparing for a new millennium. We hope we in India will be able to perceive the changes that are taking place all around us, do an anticipatory thinking and design a bright future for us.

For this Science Congress, the focal theme is: "Frontiers in Science and Engineering and Their Relevance to National Development". Therefore, the first part presents the rapid developments taking place in information sciences and how these will impact our lives. In the second part, developments in materials science, specially new materials like high temperature superconductors, nanomaterials and clusters, and smart materials will be introduced. Later, developments taking place in biotechnology and biomedical research will be pointed out separately. Some new areas of research and development in energy will be reviewed. Finally, an attempt will be made to delineate how India could also become a visible player in this fiercely competitive game of research and development.

Science today is more important than ever for us and our country. The development of a nation is directly dependent on the creation, mastery and utilization of science and engineering. Today science, engineering and economy constitute a connected network. Achievements of science and engineering are marvels of human progress, which have been utilized to solve a number of human problems, like feeding a growing population, providing energy and transportation to people, improving human health and protecting our environment and ecosystem. Today all countries of the world are seeking economic growth. Many of them like South Korea, Taiwan, The Peoples Republic of China, Hong Kong, Indonesia, Malaysia, Singapore and Thailand are making rapid economic progress. The belief in these countries is that encouraging science and technology is the path to a better future and many of these countries are expanding and increasing their support to R&D in science and technology. After the World War II, the miracle of Japan's economic growth was achieved through technological innovation and well trained manpower. Today Japan has plans to double the government's share of science and technology funding by the year 2000. China has plans to increase its R&D budget threefold by the year 2000.

We have to apply modern science and technology to solve our country's problems, to improve productivity in our economic activities and to make our services more efficient. Because of excessive and complacent dependence on foreign technology by our industry, science and technology has so far only played a marginal role in the industrial development of India. Many people even think that larger investment in R&D is not going to yield productive results. Large corporations of developed nations, which sell technologies to us at great profits, may have an interest in promoting such a thinking. In past our industry has also not encouraged our engineers to innovate and to apply results of research in produc-

*Based on the Presidential Address delivered at the 84th Session of Indian Science Congress Association held in Delhi in January 1997.

tion. The demand for indigenous technology has therefore been weak. Industry might have neglected investment in R&D so far, because, there was very little competition in the market in the past. With liberalization and opening of the markets, the age old mindsets and attitudes are changing. The industry is slowly realising that R&D holds the key to competitiveness and that R&D could enable us to meet the challenges arising due to globalization.

It may be added here that whenever a challenge was posed, and the political will and support was available, Indian science and technology has done well. One of the significant outcomes of the Indian effort has been the green revolution in sixties, which enabled India to become self-sufficient in food production. The food grain production which was ground 52 million tonnes in 1952-53 reached a figure of over 170 million tonnes by end of the seventh plan and 191 million tonnes in 1995-96. The hybrid maize, dwarf rice, hybrid sorghum, dwarf wheat, hybrid millet, etc. are high yielding varieties which were adapted to Indian conditions. This combined with enhanced irrigation and use of fertilizers and pesticides led to the green revolution. There are 25 universities in the country dedicated to agriculture. These universities and extension centres have helped the Indian farmers adopt new practices. There are a number of primary agricultural products like millet and groundnut, jute and tea where India has become the largest producer in the world.

The achievements in the space sector have also been significant, particularly in launching of satellites for communication and remote sensing. The communication facility provided by the INSAT system has helped nationwide TV and computer networking. The impact of space-based services has been felt by the common man in the area of communications, meteorology and resource survey.

In the field of nuclear technology, India has built capabilities covering exploration, mining, extraction, purification and storage of nuclear materials, production of nuclear fuel, design and construction of nuclear power reactors and their control systems, production of heavy water and reprocessing of nuclear fuels. While India's first nuclear power station at Tarapur was a wholly turnkey project with 100% imported components, the latest power station at Kakrapar has imported content of less than 10%. Other major high technology systems like radio telescopes, parallel processing supercomputers and power plant machinery are examples of our achievements through teamwork of scientists and engineers.

Technologies are changing so rapidly that it is difficult to surmise the shape of technologies in coming decades. But one is sure a new world is being ushered in by the advances in information sciences, new materials, modern biology and biotechnology. A glimpse of some major developments in these and related fields will be presented and their possible impact on our lives, will be mentioned.

Information Technology

Information has become the key element in the growth and development of any nation today. No country can be rich in the coming years unless it has a dependable telecommunication system and a robust information industry. What oil and coal were for the twentieth century, that is what information technology will be for the twenty-first century. The convergence of communication and computing is already leading to the death of distance. Today we can transmit information over great distances, and store and manipulate it at unprecedented rates. Microelectronics, optoelectronics, switching, parallel processing, software, data compression, storage and display devices are the key technologies involved in the information revolution. There are rapid advances in all these technologies which, in turn, make the changes in the information technology very rapid. Nothing is final here.

Computer is a powerful and evolving tool for managing and sharing knowledge. Today, clever software can turn a computer into a television, a canvas, or make it replay images and music, snap photographs, synthesize human speech, organise databases and libraries and present a combination of animated drawings. Computers and communications are progressively becoming cheaper and faster. For more than two decades microchips in computers have continued to obey Moore's law which states that microchips at a given price level will double in their performance every 18 months. Similarly, fibre cables, satellites, wireless transmission and newer techniques are placing low cost, high speed communication at our disposal. These factors have enabled the traditional networked computer to merge into collective identity of the network. New network

technologies like World Wide Web now allow us to share information all over a network of computers.

Convergence of computers, communication, speech, text and images also presents an extraordinary opportunity in multimedia services and applications. These developments will change the way we live, learn, work, transact our business and communicate. For example, these techniques could allow doctors to examine patients in another continent and even monitor surgical operations at very far off places. Scientists are also working on image and pattern recognition techniques that can make computers ubiquitous. Speech recognition would replace the computer keyboard for most of the uses. There are attempts to develop computer systems for recognizing faces, expressions and gestures. Such developments would enable us to create smart rooms which could see that people are in a meeting and shield them from interruptions. Such smart rooms would be networked and furnished with cameras and microphones. Thus, these rooms could relay information from the room to other interested parties on the network. The computers could also assess what people in the room are saying or doing. Computers could compare the incoming information with models they have stored in memory, and arrive at decisions by tracking people's movement, identifying them and recognizing their expressions. Therefore, in future, computers will be playing the role of attentive assistants.

The Internet is a large and global network of computers. Anybody can be a part of this network and share information with its users. The Internet provides access to essentially unlimited sources of information. Friendly ways of helping users to find what they want are already becoming available. In the course of time, procedures for information quality control will also develop. The Internet will have all the essential features of a massive library system. It will of course take time before Internet possesses a large store of knowledge to rival the best of our libraries. However, currently the Internet does allow dialogue and exchange of ideas through electronic mail, news groups, etc. Communication can be carried out at all hours and across large distances. The Internet and its successor technologies will have a profound effect on the society.

We in India should develop a national information infrastructure, where using phone lines, cables, high speed data networks, we allow open access for all to the electronic superhighway of information. All our universities and national laboratories should be connected to this information superhighway, so that researchers can not only have access to important research journals and other library material but can also collaborate across large distances. The status of libraries in our universities is very unsatisfactory. Unless we do something about it, the research in universities will suffer greatly in quality. Low cost computers and Internet connectivity could provide a satisfactory solution to this problem. Today many of our higher educational and research institutions have working Internet facilities, but many of them are operating at low bandwidth. In the area of software, India has a lot of potential. We should now aim at high quality software development for automation, networking, design activities and telecommunications. As of now most of the Internet software is imported. There is scope for us to design software for specific applications on the Internet appropriate to Indian needs. We should make every effort to see that India is not marginalized in this rapid race of information technology.

New Materials

Development of new products requires new materials. In recent years, there has been extraordinary success in developing new polymers, ceramics, composites, superconductors, nanomaterials, smart materials and biomaterials. Out of these, only high temperature superconductors, nanomaterials and clusters and smart materials are being described here.

High Temperature Superconductors

The discovery of the first high temperature superconductor, a lanthanum-barium-copper oxide in 1986 was a major advance. This compound became superconducting around 30 K (or -243°C). Till then the superconducting transition temperature was stagnating around 23K(or-250°C). Soon after this discovery there were efforts the worldover to discover materials which would exhibit superconductivity at still higher temperatures. Yttrium-barium-copper oxide (YBCO) was found to have a superconducting transition close to 90 K (or –183°C), a temperature

which is above the liquid nitrogen temperature (77K or –196°C). Bismuth- strontium-calcium-copper oxide (BSCCO) was found to have a transition temperature of 120K (or –153°C). These and other high temperature superconducting materials have taught us much new physics, but we are still far from a clear understanding of the mechanism of superconductivity in these materials.

Essentially every application of superconductivity to electric power technology depends on successful development of wires, which can carry sufficiently strong currents. People have been able to draw wires of these brittle materials which can carry currents even at high magnetic fields. BSCCO wires are made by powder-in-silver tube method to overcome brittleness. YBCO wires were made by ion beam assisted deposition. In Japan and US the possibility of replacing existing power transmission cables in big cities by BSCCO superconducting cables is being examined. Coils, motors, generators and superconducting magnets using superconducting wires of high temperature superconducting materials have been developed. Japan has successfully experimented with a levitated train that travels at about 500 km/hour on a test track outside Tokyo. This train uses (normal) superconducting magnets. These trains would need less maintenance, would be safe and comfortable and would cause no pollution. Therefore, because of its great potential in 1993, the Japanese ministry for Technology (MITI) placed superconductivity at the head of its technological priorities for the twenty first century.

Thin film deposition and microfabrication techniques are being developed to make high temperature superconducting switching devices. Such switching devices could be used to design computers which will be faster, more compact and will use less power than the current semiconductor device based computers. Superconducting Quantum Interference Devices (SQUIDS) made out of high temperature superconducting materials, can detect very weak magnetic fields, fields which are as small as a billionth or even less of earth's magnetic field. SQUIDS therefore provide a very sensitive tool for measuring extremely small magnetic fields. When a large number of SQUIDS are placed around a human head, it is possible to image currents in the brain and look for responses to various external stimuli. It can be used to map brain functions or diagnose disorder traced to some malfunction in the brain. Materials which are superconducting at room temperature, still remain a dream of material scientists.

Clusters and Nanomaterials

Clusters constitute an important state of matter. They have a large number of atoms. but are not big enough to have the same properties as the bulk liquid or solid. Their electronic, optical, magnetic and mechanical properties are size dependent. One can tune the properties of clusters by controlling their size. This offers possibilities of their technological applications.

Fullerene, for the discovery of which last year's Nobel prize in Chemistry was awarded, is a new form of carbon, a cluster containing 60 atoms of carbon. Since the shape resembles a geodesic dome designed by the famous American architect Buckminster Fuller, the sixty atom carbon molecule, C_{60} was named Buckminsterfullerene or buckyball. Fullerene is different from the known forms of carbon like graphite or diamond. Scientists predict that fullerenes will find applications in drug delivery systems, and making hairlike nanotubes of carbon of unprecedented strength.

Today it is possible to deposit semiconductor structures of 10 nanometer (a nanometer is one billionth of a meter) in length, width and height. These structures are known as quantum dots. Optical absorption for these quantum dots shifts to higher energies – away from red to violet as the dots become smaller. This property of quantum dots could pave the way for more efficient and precisely tuned lasers. These quantum dots may possibly be harnessed in future for electronic devices. Today we have no technique to make plenty of these quantum dots with good control over their purity, shape and size. If we succeed in assembling millions of dots of controlled shape and size in a predetermined geometry, we shall be able to succeed in custom designing materials with desired properties.

Many people predict startling development in nano-technology, a technology which deals with structures with dimensions of up to 100 nanometers. In nanoceramics, the ceramic nanoparticles are incorporated chemically into complex structures. One product of such process is the scratch resistant plastic glass which has a coating of nanoceramics. This

process has been a boon to optical industry because with the nanotechnology it is possible to create coatings that are transparent, scratch resistant and dirt repellent at the same time. Efforts are being made to develop nanoceramic coatings which would offer protection against corrosion.

Smart Materials

Scientists have succeeded in developing smart materials which can adapt to a changing environment. In these smart materials one weds structural materials with sensors. Such a material can monitor signs of failure say in bridges, submarines or aeroplane wings. Some piezoelectric ceramics (lead zirconium titanate) and polymers (polyvinylidene fluoride) are pressure sensors and can be used to transform electrical current into vibrations. Shape memory alloys (like nitinol, a nickel titanium alloy) are materials which can be deformed into a desired shape, but return to original shape when heated above a certain temperature. When a shape memory alloy is incorporated in a smart system in its low temperature shape, it exerts a force when heated. Other kinds of sensor materials that are used for producing smart materials are electrorheological fluids, optical fibres, magneto-restrictive and chemoactive materials. A smart fibre optic network could monitor the behaviour and changes in a composite material. Such an optical fibre could send signals when the material gets overstressed or weakened beyond a limit. Engineers are trying to build bridges incorporating smart materials that can detect corrosion and counter it. The smart materials will find more and more use in many structures and gadgets in coming years.

Bose Condensate

A new state of matter, called the Bose Condensate, was first realized in June 1995. This startlingly new phase of matter follows from the epoch making discovery of Bose Statistics by our great scientist Professor S.N. Bose in 1924. In Bose condensation a cloud of atoms is cooled close to absolute zero. The huge number (about a million) of atoms at these extreme low temperatures act like a single entity. During 1996. Bose condensates have been at the centre stage in Physics. Such outcomes of the research by Bose, Raman, Saha and others show that Indian scientists are as capable as others in making great and truly outstanding discoveries in sciences.

Biotechnology

Biotechnology is the integrated use of biochemistry, molecular genetics, microbiology and processing technology, and it aims to find applications of microorganisms or cells for practical or industrial purposes. Biotechnology is a rapidly expanding collection of tools and techniques. It holds immense potential in changing the quality of our life in the years to come.

The foundations of molecular genetics were laid in 1953 by the discovery of the famous double helix structure of DNA by Francis Crick and James Watson. The term genetic engineering is applied to an ever growing set of techniques for manipulating genes. In recombinant DNA technique, the fragments of DNA from a cell are extracted and combined with similar fragments from some other organism's DNA to produce a new DNA.

Genetic engineering has the potential for alleviating diseases by producing new drugs, better disease diagnostics, and fighting starvation by developing high yielding and pest resistant plant varieties. There are applications of genetic engineering in environmental protection and remediation. Amongst the earliest successes of biotechnology was the manufacture of human insulin. Other products like interferon, growth hormones and diagnostic kits have been produced. Microorganisms can be used as factories to manufacture drugs, drug intermediates or rare chemicals. New technologies are also being tried for producing rare chemicals like repellents, moisturizing materials, drugs and biosensors by using marine and tropical organisms. Biotechnology has a large potential in the industrial process of fermentation for enhanced production of alcohol, vitamins, antibiotics, oils and fats. The conventional chemical industry is highly polluting whereas biotechnology could provide us with an environment-friendly alternative.

Plant genetics has enabled us through the use of recombinant DNA technique to engineer certain crop plants which are resistant to insects, diseases and external conditions like heat, drought and saline soil. The recombinant DNA technology is superior to the method of producing hybrids by cross-fertilization, because cross-fertilization is time consuming, can only be done for closely related varieties and the nature of the hybrid can not be precisely controlled.

In India, the recombinant DNA technique is in infancy as far as the development of transgenic plants is concerned. We need to enhance our capabilities in recombinant DNA technology along with strengthening our efforts in the conventional plant breeding. Plant tissue culture seems to be the most widespread biotechnological practice in India. We should also strengthen our efforts on biofertilizers and biopesticides. Wild plants and traditional cultivars, among other biological resources, represent raw genetic material for crop improvement and plant based industry. India has 8% of the estimated biodiversity of the world. Efforts should be made to use modern tools for the conservation of endangered plant species. Many of these are of economic and medicinal value. India should develop scientific packages for cultivation of medicinal and aromatic plants. Based on the rich traditional knowledge of herbs and traditional systems of medicine, and using appropriate biotechnology inputs, we could produce herbal products and plant based drugs which could have a huge international market.

Biomedical Research

New technological tools like biotechnology, faster computers, telecommunications, robotics are coming together to transform health care and medical research. The recent developments in information technology now permit lot of information like X-ray pictures to be sent across long distances via satellites or fibre optic cables. The multimedia revolution will let the patients communicate with doctors from long distances. Medical imaging is already being used by doctors in diagnosis of diseases. With powerful computers one can get still better images of the parts of human body and can have views from different angles and at different depths. Robots can be used in some operations to do things better than a human hand can do. The electronic storage of all medical records should be of great help to doctors in decision making.

The human genome project is aimed at mapping and sequencing every single of the estimated 100,000 human genes. The project involves biologists, chemists and computer scientists to sift the huge amount of data that is generated. Once the human genome is mapped and sequenced, it would be possible to understand the diseases better. Specific genetic mutations are associated with specific diseases. Diagnostic tests for genetic disorders can indicate how likely a person is to develop an illness. Human genome mapping would also help in drug development research, because genetic disorders connected with diseases will point the way to molecules which may be possible drugs for a disease. Human genome mapping and the knowledge of controls for cellular development may permit in future the regeneration of an entire organ from a small number of cells.

Conventional forms of drug administration relies on pills, ointments and intravenous solutions. A member of new drug delivery approaches are being developed. These are drug modification by chemical means to selectively alter biodistribution, drug entrapment in microparticulates that are injected into the blood stream, and drug entrapment within a polymeric material for controlled delivery of a drug at a predetermined rate.

Cancer is a major killer disease today. Cancer cells proliferate without any external control and migrate from site to site and form tumour cell masses at different parts of the body. In a healthy body normal cells only reproduce when instructed to do so by other cells in the neighbourhood. Tumour cells evade all controls that are there for normal cells. Metastasis, the spread of the cancer to distant sites in the body is what makes cancer so deadly. Very little is known today about the metastatic spread on a molecular basis. It is however known that the malignant transformation of a cell comes through mutations in specific classes of genes in the cell. The differences between the cancer and normal cells are minimal and this makes targetting of anticancer drugs very difficult. Lot of research work is aimed at fighting cancer using our own immune system. This is a difficult task because cancer cells use variety of tactics to evade immune attack. Molecular detection tests to look for tumour before any symptoms occur, are being developed in the laboratory. It is possible that in future dramatic improvements may take place in our ability to treat cancer.

AIDS (acquired immunodeficiency syndrome) poses a threat to India as a large number of people are infected with HIV (human immunodeficiency virus). There are no drugs today for AIDS. The problem which has dogged anti HIV drugs is that resistant mutant forms of virus are formed within mere weeks. Lot of research work is being done at

many research centres in the world in search of a vaccine against HIV.

Understanding functions of the human brain and the nervous system presents a formidable challenge. A vigorous effort is being made to unlock secrets behind the brain. Diseases affecting the brain are considered to be the most difficult to cure. Such disorders include Alzheimer's disease, which brings on dementia, and Parkinson's disease which disables motor functions. Aging population tends to increase the visibility of these diseases. Understanding brain and nerve functions may throw up new possibilities for treatment and cure of these diseases.

In India advanced tools and techniques of modern biology have not yet permeated the biomedical research. It is necessary that medical education in India should take note of modern biology and human genetics. There is need for initiating networked programmes involving medical institutes and colleges, research laboratories and universities to understand tropical diseases like malaria, leishmania, filaria and diarrhoeal diseases on molecular basis. Research on tropical diseases will probably be neglected by developed countries.

Developments in biomedical research and genetic engineering have already generated debate on ethical issues. People are worried about risks to human health and environment from transgenic products. Genetic tests can identify persons who are likely to develop a particular genetic disorder. Questions are being raised whether such an information if made public, may lead to the person being stigmatized socially. Can employers and insurance companies insist on genetic information about an employee or a client? Ownership of genetic information is a vexed question. All these and many more ethical and social issues are there to be resolved.

Energy

Per capita consumption of energy in India is very low compared to developed countries. In any developmental plan of our country the growing demand of energy assumes great importance. In a long term view of national needs of energy a mix of technologies will almost certainly be needed. The major effort in next decade would have to be through an increase in the production of coal and a search for new reserves of oil. Our oil reserves are limited. Our dependence on imported oil is on the rise. We have large reserves of coal, but Indian coal has high ash content. Coal used for power generation has ash content of about 40%. Because of this, we should develop technology to convert our high ash coal into a source of clean energy using coal gassification technology. This should be taken as a priority programme because in future our country will have to rely more and more on coal as a source of energy.

India should also expand its nuclear power programmes. Nuclear energy could play an important role in meeting our bulk energy requirement. Our expertise in the field of nuclear power technology as well as the related research areas, is an asset for us. Further, R&D in Advanced Heavy Water Reactor Systems and Fast Breeder Reactors is needed.

We should also give due emphasis to new technologies for solar energy and hydrogen energy. India should invest heavily on photovoltaic research. At the laboratory scale it has been possible to make amorphous solar cells in Japan, where the cost of photovoltaic electricity is comparable with cost of commercial power. India is advantageously placed with respect to sunlight and solar energy could be a supplementary source of energy. Hydrogen is a clean fuel with no particulate emission during combustion. At present hydrogen is produced by thermal cracking of fossil fuels. This costs energy and also gives carbon dioxide which contributes to global warming. Lot of research is being done on genetic modification of microorganisms to produce hydrogen. The intention is to create photosynthetic bacteria which can convert with the help of light organic waste into hydrogen and other byproducts. The problem of storage of hydrogen compatible with particular applications is being studied. There are alloys which can absorb and store hydrogen. Fuel cell research promises to provide efficient and clean method of producing electricity out of hydrogen.

Our Competitiveness

If we think of the frontiers in science and engineering mentioned above and other developments in areas which we have not touched upon, and try to assess what we are doing in our country, we notice a widening gap between status of science and technology in our country and the frontiers in these areas. The situation will worsen if some effective steps are not taken early enough.

It is the universities which foster and nurture creative scientists and engineers. Universities are the real homes for advanced research and training. Universities also have an invaluable role in educating young scientists. In recent years, the funds for universities are shrinking. An atmosphere of doom and gloom is prevailing in most of the universities. Science is not attracting good students. There appears to be a virtual absence of quality standards in many of our universities and there is lot of interference in university affairs from outside sources. Universities no longer remain places where one values pursuit of truth, tolerance, rationality, free thought and scientific outlook. We have to strengthen the university system so that the science in our country will prosper. We should increase the budgetary support to science education in universities manifold. There should be sufficient funding available to support excellence and quality in the higher education. Good research is really centered around individuals and small groups in universities. When necessary, competent individuals and groups should receive special support from government sources without much difficulty and bureaucratic delays.

In order to be internationally competitive, our country has to increase R&D funding. Industries in India have to also invest much more in R&D than what they are doing today. Today not many industries in India are interested in exploring knowledge at frontiers in order to design innovative products of future. Our industries should also venture into a few cutting edge technologies and aim at reaching the pinnacle of technological sophistication and ingenuity. We have to adopt a cooperative and synergetic approach where industry, national laboratories, academia, financial institutions and government can work together. We should import technologies with an aim of assimilating them and improving upon the imported technologies in a substantial way. CSIR has drawn a bold road map to develop globally competitive technologies in niche areas. For this we shall have to modernize our national laboratories and provide them enough resource to acquire modern equipment, so that they do not feel handicapped while undertaking projects of technology development. Industry should also strive to develop entirely new products and technologies which can be exported on the strength of their quality and innovativeness. We have to use our high quality manpower and our massive R&D infrastructure to achieve leadership position in a few chosen areas of technology. The technology development fund which has been established by the government should be used to fund such developments in a focussed manner. We have to take development of globally competitive technologies as a matter of great national concern, because ultimately it is technology which accounts for a major share of economic growth. The development of technologies in future can not be divorced from environmental concerns.

Availability of a new ecofriendly technology will not mean that it will be used by industry. Prices, institutions and policies will all play a role in the adoption of technology. Technology is only a small part of the whole issue. There are other factors like the attitude of industry, political leadership, capital and education especially technical education, which need to be considered before we march ahead towards growth and development.

South Korea plans to increase its R&D spending to over 5% of its GDP by the year 2000. China plans to increase its R&D investment from 0.5 to 1.5% of GDP by the year 2000. Unfortunately, India's R&D expenditure has come down to 0.89% of GDP from 1.1% earlier. We need to realize that in order to be able to do competitive research and development we have to bring our R&D expenditure to at least about 1.5% of GDP and focus our efforts on a few selected programmes and projects. The reduction of R&D funding is a short sighted policy and would weaken us devastatingly in the long run.

We scientists, want people to support us and understand our needs. We therefore have to inform people about science, why science is needed, what we are doing and why. We have to build partnership with public, industries, politicians and bureaucrats. We want informed friends of science at all places.

When changes which affect our future are happening and will happen at such a rapid rate, and are based on science and technology, it is necessary that scientists be more close to decision making. It is essential to have an apex advisory committee on science and technology which can provide the Prime Minister and the government a scientific analysis of issues

connected with sustainable and indigenous development based on science and technology.

A glimpse of the rapid changes which are taking place in Frontiers in Science and Engineering and the challenges these pose to us in India has been presented here. These changes and challenges should inspire each of us into right action, with all our strength and energy, so that the world will some day in future look at India with respect for its strength in science and engineering.

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Selection and Evaluation of Research and Development Projects

R K Das[a], K C Sahoo[b], H S Ray[c] and P K Sahoo[c]

[a]College of Engineering and Technology, Orissa University of Agriculture and Technology, Bhubaneswar 751 003

[b]Department of Industrial Engineering and Management, Indian Institute of Technology, Kharagpur 721 302

[c]Regional Research Laboratory, Bhubaneswar 751 013

The project selection and evaluation methods in a CSIR laboratory has been reviewed. This applies only to in-house projects, externally funded ones are monitored by the sponsoring agencies. However, there are certain lapses and the progress is not satisfactory. Factors and weightage have been proclaimed and depending upon the achievements, annual scores have been calculated. In case the targets are not achieved it has been suggested to drop the project after specified period.

Introduction

The criteria for selection of research and development (R&D) projects depends primarily on the objectives of the organisation in which research is being conducted. If an organisation has been set up for basic research, then creation of new knowledge will be important criteria. On the other hand, for a private sector industry producing consumer products, increase in profit is the only criteria for selection of projects in the R&D unit of the organisation. In case of R&D within the public sector industries in addition to profit, marketable and quantifiable outputs one has to take into account the contribution to the national economy and social benefits of R&D. Waqif[1] described different factors as the characteristics for project selection and evaluation. Timing of research, possibility of protection of results through patents, marketability, financial input and production factors are few to be mentioned.

The present investigation analyses project selection and evaluation methods being carried out at RRL, Bhubaneswar, which is one of the national laboratories under Council of Scientific & Industrial Research.

Laboratory R&D objectives

The objectives of the laboratory are directed for carrying out R&D work in the areas related to:

Characterisation of minerals, beneficiation of lean and complex ores and agglomeration of ore fines and concentrates.

Pyro and hydro-metallurgical extraction of metals, preparation of alloys and recovery of metal values from wastes.

Development of special materials and composites.

Preparation and synthesis of organic and inorganic chemicals from marine, forest and mineral resources.

Design and development of process equipments and control systems.

Survey, introduction and cultivation of aromatic, medicinal and other economic plants.

Development of physico-chemical and analytical methods.

Basic scientific research to supplement the research and development work enumerated above.

Further, the laboratory

Provides technical advisory services, scientific and industrial liaison, analytical and testing facilities and training programme.

Assists State and Central Governments in formulation of plans and schemes as and when required.

In the authors' laboratory (RRL) mainly two following categories of projects are carried out (i) In-house and (ii) Externally funded. The in-house projects are in general completely financed by CSIR. The externally funded projects (wholly or partially funded by CSIR) are time targeted and also result oriented. These are a source of earning for the laboratory and in some cases for the investigators also. In principle both in-house and externally funded projects are finally approved by the internal committee of the laboratory and sometimes in the open house meeting of scientists. However, because of the earning criteria, the proposals for externally funded programmes are generally approved and accepted.

Of course the proposals for all in-house projects are not always accepted, because the laboratory desires to restrict the total number to a viable limit. Different criteria are taken into account before accepting the project. These include the aim and objective of the project, survey of relevant literature, avoiding possible duplication of work, marketability of the product or process, proximity of raw material in nearby locality, expertise and facilities available in the laboratory etc.

All projects are subsequently broken into different activities and Project Monitoring Chart is prepared describing these activities, involvement of scientists and expected completion time of the activities. The progress is reviewed from time to time and assessed in terms of completion of the targets, publication of results as patents and papers and negotiations with user industries. In case the progress is not satisfactory, the project may be either terminated or extended.

Deficiency and remedial measures

In reality, the aim and objectives of every project are sporadically modified and results are often not properly documented. Moreover the required inputs are sometimes not correctly accounted and therefore projects are continued indefinitely. Personal prejudices and shortcomings of the concerned scientists contribute to this problem. In an earlier survey[2] it was pointed out that duplication of research work is common in many of the national laboratories. In this regard a data base has to be created and the research programmes of all the laboratories have to be stored centrally to avoid unnecessary utilisation of funds due to duplication.

Funding is a major problem in case of R&D projects. and because of this, most of the In-house projects remain in either laboratory scale or bench scale. Hence it is essential to generate funds from relevant and concerned industrial houses. The industrial houses however, need to be convinced about the potential monetary benefits if the results are commercialised, in addition there are income tax benefits from R&D expenditure.

Recently CSIR has given directives to its research laboratories to generate more funds from externally funded projects. This is a motivating factor for RRL and other laboratories. It should be remembered that the laboratory gets consultancy projects based on its expertise and capabilities developed through different in- house projects carried out earlier. At present RRL's 75% of the projects are externally funded i.e., sponsored, consultancy, collaborative or grant-in-aid projects (59 out of 77). In the process no time is available for carrying out in-house projects. Hence it may so happen that the laboratory would exhaust its knowledge base and may not be able to cater to the needs of the industrial houses / outside agencies. In this context it is essential that long term in-house projects should also be continued. Further the selection of projects should always be made in line with aim and objectives of the laboratory. Projects like accounts keeping, inventory maintenance by the computers, routine analysis, ordinary literature survey etc. should not be encouraged even though these may generate substantial amount of external funds.

Model for project evaluation

Rahman[3] has reviewed goals for basic and applied research under different national and cultural contexts. Chatterjee[4] has discussed the science and technology in India. Onrad and Wahl[5] stated 60% of research to be in-house in the industry for industrialised countries, but only 30% in developing countries. The share of state in R&D financing in 1985 in India and Korea was 74% and 27% respectively. A framework[6] of extended input and output model including R&D activities and evaluation of R&D efficiency were discussed by various authors. Comparison was made for the Science and Technology policy in Japan and China. The performance appraisal scales for R&D scientists and Engineers with different weighted index have also been studied[8]. Subramanian, *et al.*[9] has tried to asses the national perform-

ance in Basic research with focus in U.K. and Govindarajulu[10] studied the evaluation for effectiveness of indigenous R&D efforts.

A project evaluation methodology has been suggested with reference to the objectives of the laboratory and the prevalent situation at RRL, Bhubaneswar. Different factors like report writing, publications, patents, possible technical break through, projects on effective pollution control etc. have been considered. Presentation of a paper in conference has been given less significance than the actual publication. Again publication in an inter-national journal has been given extra weightage. The response from any industrial house for the project has been given the priority area because of the present economic liberalization and open market system. The weightage of factors are given as absolute numbers (Table 1). Intangible benefits which can not be quantified are given a score in a three point scale (0-3). Depending upon the criteria, the weightage & respective scores are computed for a specific project. Then the total score is to be checked for the continuation/termination of the ongoing projects.

As specified earlier[11], in RRL the ongoing projects are intermittently reviewed by the an internal committee called Research Appraisal and Review Committee (RARC). It is necessary to compare the points scored by a particular project with the minimum possible score before granting extension for continuing. The evaluation procedure is given in the following pages. However, this would be only applicable to the In-house projects i.e. run by the internal funds of RRL. Externally funded projects are the time targeted ones approved by the outside agencies. Here one should not readily calculate the scores along the above lines. However, RARC reviews the progress of such projects to ensure that work is carried out as promised to the sponsoring organisations. The procedure for evaluation of the progress of the In-house projects are outlined in Tables 1 to 5. Few hypothetical cases are enumerated and the possible scores are calculated. In case of scores below 0.5 after first year, 0.7 after second year and 1.05 after two and half years, the projects have to be terminated.

Table 1 — Factors and Weightage:-(Project duration 3 Yrs.)

Sl.No.	Factors	Weightage in % age	Score	Product
1.	Report writing/attending Seminar/Proposals sent	6	-	-
2.	Progress according to bar chart	10	-	-
3.	Presentation in a conference	2	-	-
4.	Publication in Indian journals	3	-	-
5.	Publication in Foreign journals	6	-	-
6.	Response of Industrial houses or other research groups to the findings of results	15	-	-
7.	Possibility of technical break through	25	-	-
8.	Patents accepted/sealed	10	-	-
9.	Possibility of collaboration between other research labs. referring the ongoing projects	10	-	-
10.	Project leading to pollution control	5	-	-
11.	Addition to G.N.P. by import substitution/export	3		
12.	Project leading to energy conservation	5	-	-

Conclusions

Weightage have been given to different factors like publication, patents, report writing, pollution control, collaboration with other laboratories, response of the industrial houses , etc. and corresponding scores have been given. Depending upon the weightage, maximum achievable scores have been predicted to be 0.84, 2.84 and 2.94 after one year, two years and two & half years respectively. It has been suggested to drop the project after first year if the score was below 0.5 and after second year if the score was equal to or more than 0.7.

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Table 2- Scores for Different Reserch Output

Factors		Score			
		3	2	1	0
1. Number of report written/proposal sent	1 Yr	-	> = 1	-	-
	2 yrs	-	> = 2	> = 1	-
	2&1/2yrs	-	> = 3	> = 2	-
2. Progress according to bar chart	1 Yr	70-100% complete	40-50% complete	25-40% complete	< 25% complete
	2 yrs	85-100% complete	60-70% complete	40-60% complete	< 40% complete
	2&1/2yrs	95-100% complete	80-95% complete	70-80% complete	< 70% complete
3. No. of presentation in a conference	1 Yr	>=1	-	-	
	2 yrs	>=2	>=1	-	
	2&1/2yrsYr	>=3	>=2	1	
4. No. of publications in India.	1 Yr	>=1 letter of acceptence	1 sent	-	
	2 yrs	>=1 already published	>=1 letter of acceptence	-	
	2&1/2yrsYr	>=2 already published	>=2 letter of acceptence	1 published	
5. No. of publications in foreign journals.	1 Yr	One accepted	-	-	
	2 yrs	One ore more accepted	-	-	
	2&1/2yrsYr	Two or more accepted	One sent	-	
6. No. of response from industraial house/ reseach laboratories	1 Yr	-	-	-	
	2 yrs	>=1	-	-	
	2&1/2yrs	>=2	1	-	
7. Possibility of techno-logical break through	1 Yr	-	-	-	
	2 yrs	Approved by RARC/RC	-	-	
	2&1/2yrs	Based on conform result	Approved by RARC	-	
8. No. of patents	1 Yr	-	-	-	
	2 yrs	-	>=1 filed	-	
	2&1/2yrs	One accepted	>=2 filed	1 filed	
9. Possibility of collaboration with other lab.	1 Yr	-	-	-	
	2 yrs	1 lab.	1 lab.	-	
	2&1/2yrs	>=2 labs.	-	-	
10. Projeact leading to ollution control	1 Yr	-	-	-	
	2 yrs	Effluents non-toxic	-	-	
	2&1/2yrs	Effluents usable	Possibility of usages	Non-toxic	
11. Addition to G.N.P. in crores of rupees	1 Yr	>=50 estimated	>=25 estimated	>=10 estimated	
	2 yrs	>=50 indicated by result	>=25 indicated by result	>=10 indicated by result	
	2&1/2yrs	>=50with confirmedresult	>=25with confirmedresult	>=10with confirmedresult	
12. Project leading to conservation of energy	1 Yr	-	-	-	
	2 yrs	May be possible	Non-conv.energy usable	-	
	2&1/2yrs	Definitely possible	May be possible	Non-conv.energy usable	

Table 3 — Evaluation of Project* after one year (Max. score possible, 0.84; min. score expected)

Sl.No.	Factors	Weigh-tage in % age	Score	Product
1.	Report writing/proposal sent for sponsoring (One)	6	2	0.12
2.	Progress according to bar chart (Min 40-50%)	10	2	0.20
3.	Presentation in a conference (One)	2	3	0.06
4.	Publication in India (One sent)	3	2	0.06
5.	Addition to G.N.P (Min. 25 crores)	3	2	0.06
				Total 0.5

* Project is to be terminated if the score is below 0.5.

Table 4 Evaluation of Project* after 2 years (Max. score possible, 2.84; min. score expected)

Sl.No.	Factors	Weigh-tage in % age	Score	Product
1.	Report writing/Proposal sent for sponsoring (2)	6	2	0.12
2.	Progress according to bar chart (60-70% of total)	10	2	0.20
3.	Presentation in a conference(2)	2	3	0.06
4.	Publication in India (one accepted)	3	2	0.06
5.	Patent (one filed)	10	2	0.20
6.	Addition to G.N.P. (25 crores)	3	2	0.06
				Total 0.7

* Project is to be terminated if the score is below 0.7.

Table 5 — Evaluation after 2½ years (Max. score possible, 2.94; min. score expected)

Sl.No.	Factors	Weigh-tage in % age	Score	Product
1.	Report writing/Proposal sent sent for sponsoring (3)	6	2	0.12
2.	Progress according to bar chart (80-90% of total)	10	2	0.20
3.	Presentation in a conference(2)	2	2	0.04
4.	Publication in India (2 accepted)	3	2	0.06
5.	Publication in foreign journal (1 sent)	6	2	0.12
6.	Response from Industrial house/other labs. (atleast 1)	15	2	0.30
7.	Patents (1 filed)	10	1	0.10
8.	Pollution aspect (effluents non-toxic)	5	1	0.05
9.	Addition to G.N.P.	3	2	0.06
				Total 1.05

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S&T Planning in the Area of Metal Matrix Composites — A Delphi Study

S Suresh Kumar and K G Satyanarayana

Regional Research Laboratory (Council of Scientific & Industrial Research), Trivandrum 695 019, India

and

R Sudhir Kumar and L S Ganesh

Indian Institute of Technology, Madras 600 036, India

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The paper describes the S&T planning priorities in the area of Metal Matrix Composites (MMC) with particular reference to Aluminium Matrix Composites. A formal technique like Delphi has been used to address the future need and assess the current status vis-a- vis topical issues in this area of importance. S&T planning in the area of MMC is confronted with the problem of systematic idea generation and project initiation in the developing country context with problems of resource constraints and expertise / infrastructures paucity. At the same time, there is growing interest in planning for futuristic S&T areas in a manner as to be of potential interest to the researchers, keeping in view expertise profile, areas of relevance and topicality, future interest and contextual constraints in terms of logistics and funds. This paper also attempts to address the issues in the area of MMC to derive research imperatives in a contextually specific manner.

Introduction

Metal Matrix Composites (MMC), one of the advanced engineering materials, are produced by the incorporation of dispersoids (continuous fibres/discontinuous-powder, whisker, etc.) into a metal matrix through various processing techniques. These include: solid state (powder metallurgy and mechanical alloying) or liquid state (solidification). Different alloy systems (Al, Zn, Cu, etc.) as matrices and various dispersoids (Al_2O_3, SiC, Carbon fibre, etc.) have been used to produce MMC by one or more methods mentioned. Most of these systems have been characterized in respect to their properties and microstructures. Many successful attempts have been made to fabricate several products for aerospace, automotive and general engineering applications. While some of these are productionized, others are in prototype development and testing stages. Fabrication, characterization and application of MMC have been reviewed from time to time[1-4]. International and National status on MMC development and applications as well as market and strategy are subsequently discussed.

International Scene

The forecast of 25% growth rate for MMC is one of the highest predicted in the recent years amongst the new materials[5]. M/s Duralcan, USA, and M/s. Hydro aluminium, Norway are the only two commercial manufactures of cast MMC internationally known with production capacity of 200 kg to 8 tonne/batch[6]. The MMC ingots produced by these were characterized by various researchers worldover which revealed superior specific properties over the monolithic alloys and ability to be shaped by conventional metal processing techniques. Prototype components for aerospace/automotive and other sectors are produced and are being evaluated, involving user industries [7]. The components include: camera gimbal, brackets, optical platform, aircraft control flaps, speed brake, ballistic armour, etc., for aerospace / defence applications. Pistons, connecting rods, cyl-

inder liners, engine block, gear shift fork, suspension arm, etc., are for automotive applications. Also, other general applications include packing for supporting electronic devices, tennis racquet, bicycle components, etc.

Some of the user industries involved include: General Motors (GM), Ford, Mazda, Honda, Toyota, etc., in the USA/ Japan and the European countries, European Railways and sports cycles in Scandinavia and NASA and military sectors in the USA/the UK etc[8]. Main attraction for automotive and aerospace applications of MMC is considerable weight saving (50%) over the conventional materials, such as Cast Iron(CI) used in addition to fuel saving and increased efficiency in heat conduction (3-times thermal conductivity than conventional material used), reduction in vibration and noise, in particular, for automotive applications. Presently, GM and Chysler models are testing the rear brake clutches replacing cast iron in their cars with MMC (by 1997), using Duralcan MMC. Honda engineers have developed Al cylinder block with an integrally cast Al MMC liner (weight reduction obtained 50% over CI block and 20% over Al blocks with CI liners) while Toyota Engineers have replaced hub of crank shaft damper pulley with MMC (40% reduction in hub and 20% in crank shaft pulley) resulting in enhanced engine performance[9].

Brake drums (5 to 10 kg) made of Al359-20% SiCp, Al6061-20% Al_2O_3, Al2681-20% Al_2O_3, Cast composites supplied by Duralcan have been tested by the Fiat Research Centre as replacement for CI brake drums. This reduces the weight of car by 1% and Al359- 20SiCp was found to be most suitable amongst the three components. Similarly the drive of Al-fibre gave 50% reduction compared to steel shafts and does not require centre bearings. This has been exhibited to the SAE Expo by GKN Automotives, Michigan (the USA)[9].

National Scene

In view of the importance and unique characteristics of MMC, processing was started in the country about three decades ago mainly with academic interest. At present, about fourteen institutions are working in the country on MMC and mostly the work is based on Al alloy as a matrix with different dispersoids and various processing techniques such as stir casting/squeeze casting/infiltration/spray deposition/powder metallurgy. Table 1 lists the major institutions in the country which are engaged in R&D of MMC and the present status including possible potential users for MMC in the country. It may be observed from Table 1 that technology to produce small quantity of MMC (up to 20 kg) with reproducible properties has been developed in the country and many industries, particularly in automotive /space and defence sectors are showing interest in evaluating them for their use to get convinced for their techno-economic feasibility in the Indian context despite availability of such information worldover. Much of the work is thus confined to laboratories with possibility for production in small quantities (25 to 30 kg). While several industrial applications are on the anvil abroad, there is a slow and late thinking on this in India. In fact, the cost of MMC produced by PM technique by NFTDC, Hyderabad, based on DMRL process is about Rs 5000/kg and is available commercially while that produced by casting route is about Rs 250/kg as per the RRL-T process referred to NRDC. The indigenous technology to produce cast MMC based on the processes developed by RRL-T and RRL-Bhopal are available with NRDC. However, there is a need to produce MMC at least at 100 kg/batch for any breakthrough toward industrial applications, since metal casting industries handle 100 to 500 kg level metal in a batch for making industrial components for viable commercial production. This scaled up facility reveals the reliability and batch-to-batch consistency which are now the serious limiting problems for the industry. Once MMC is reliably produced at an acceptable cost to the customer, it has to undergo qualification for various applications.

Presently, about 50-60 S&T personnel are engaged in MMC R&D with sponsorship funds of about Rs 20 lakh/y, mainly from AR&DB/DST. In addition, funds from Defence/Space sector and HRD are also provided in the work carried out at HAL/DMRL, etc.

Except for about 20 kg of AlMMC obtained free of cost by RRL-T form Hydro aluminium, Norway, and may be of the same amount from Duralcan by others mainly DMRL, Hyderabad, for comparative studies, there seems to be no real importance of MMC abroad and one can think of exporting it to such countries.

Table 1 — Status of metal matrix composite development in India

Organisation	Process adopted LM-Liquid Metallurgy SM- Semisolid Metallurgy PM-Powder Metallurgy	MMC systems studied	Scale and nature of development	Component identified for field trial and evaluation report
Hindustan Aeronautics Ltd, Bangalore	LM PM	Al 6061/2024 - SiCp Mg base composites	35 kg*	Aircraft components for evaluation
Indian Institute of Science, Bangalore	Strir casting/pressure less infiltration/squeeze casting	Al-Si with graphite or SiO_2 dispersoid Al_2O_3/SiCp	2-5 kg	Al-graphite bearings performed equivalent to that of Cu-Sn bearings. Al-graphite pistons have shown 10% savings in oil and fuel Automotive components fabricated
Roorkee University, Roorkee	LM and SM	Al-alloy Al_2O_3	1.2 kg	Processing and evaluation

— contd

Table 1 — Status of metal matrix composite development in India —(contd)

Organisation	Process adopted LM-Liquid Metallurgy SM- Semisolid Metallurgy PM-Powder Metallurgy	MMC systems studied	Scale and nature of development	Component identified for field trial and evaluation report
Regional Research Laboratory, Bhopal	Strir casting squeeze casting	Al-Si alloy with graphite or talc/dispersoids	2.5 kg process assigned to NRDC	Brakedrums for Vans and components for mineral equipment have been made in collaboration with user industries. Pistons have also been made at an industrial site
Banaras Hindu University, Varanasi	Strir casting	Al-Pb	2-3 kg	Bearing for automotive application showed comparable performance with Cu-Sn bearings

— contd

Table 1 — Status of metal matrix composite development in India —(contd)

Organisation	Process adopted LM-Liquid Metallurgy SM- Semisolid Metallurgy PM-Powder Metallurgy	MMC systems studied	Scale and nature of development	Component identified for field trial and evaluation report
Regional Research Laboratory, Thiruvananthapuram	Strir casting	Al-Si-graphite LM 25 SiCp Al-Zn-Mg-Cr-Cf/SiCp/TiO_2	5-25 kg Wrought aluminium alloy base composites are extruded at NPL, New Delhi, and evaluated	Pressure die cast Al-graphite composite contactor switches have shown performance equivalent to that of phosphor bronze at M/s. Hindustan Latex Ltd., Trivandrum. Gravity die cast Al-graphite cylinder liner components have exhibited no carbon deposit no scoring on piston after running for 100 h endurance test at M/s TVS-Suzuki Ltd, Hosur

— contd

Table 1 — Status of metal matrix composite development in India —(contd)

Organisation	Process adopted LM-Liquid Metallurgy SM- Semisolid Metallurgy PM-Powder Metallurgy	MMC systems studied	Scale and nature of development	Component identified for field trial and evaluation report
			Technology for making aluminium graphite composite is assigned to NRDC, New Delhi	Gravity die cast and machined bearings/bushes have been supplied for field trials at BHEL (Bhopal)/M/s Naveen Industries, New Delhi, M/s TVS-Lucas, Madras

— contd

Table 1 — Status of metal matrix composite development in India —(contd)

Organisation	Process adopted LM-Liquid Metallurgy SM- Semisolid Metallurgy PM-Powder Metallurgy	MMC systems studied	Scale and nature of development	Component identified for field trial and evaluation report
			Patents for separation mixing and dispersion	Sand cast Al- Graphite fan components were supplied for M/s Ralli Wolf Ltd., Bombay and pistons for 2 and 4 wheelers were made in local foundries at Nasik and Agra. VRDE, Ahmedabad is evaluating the pistons. Component (5kg) for elecrodynamic vibrator system made for a private company,
Indian Institute of Technology (IIT), Mumbai 400 076	Strir casting powder metallurgy	Al-Cf/siCp/TiB Cu-W/TiC/ClO_2, etc.	Synthesis and characterization	—
Indian Institute of Technology, Madras 600 036	Squeeze casting	Al base compound with performance	Synthesis and characterization	Automotive components

— contd

Table 1 — Status of metal matrix composite development in India —(contd)

Organisation	Process adopted LM-Liquid Metallurgy SM- Semisolid Metallurgy PM-Powder Metallurgy	MMC systems studied	Scale and nature of development	Component identified for field trial and evaluation report
IIT, Kanpur	PM	Pb-Zn/Al_2O_3 Austinitic steel-Y_2O_3/Al_2O_3	Synthesis and characterization	Cutting tools fabrication and evaluation
DMRL, Hyderabad	PM	Al6061-Al_2O_3/TiC Al2124-SiCp/TiCp/TiB	Synthesis and characterization	Space and defence components fabricated and being evaluated
NIFFT, Ranchi	LM	Al-SiCp	Synthesis and hot working	—
NPL, New Delhi	LM Spray casting	Al 6061/SiCp Al 2124- SiCp Al-Zn-Mg-Cf Al-flyash	Extrusion composites	Rods/tubes/sections/and a few automotive

— contd

Table 1 — Status of metal matrix composite development in India —(contd)

Organisation	Process adopted LM-Liquid Metallurgy SM- Semisolid Metallurgy PM-Powder Metallurgy	MMC systems studied	Scale and nature of development	Component identified for field trial and evaluation report
NAL, Bangalore	Electro co-deposition	Electro composites Cu, Ni base with Al_2O_3, SiCp	—	Cutting tool wear resistance surface
R V College, Bangalore	LM	Al particulates composites	Synthesis and characterization	—

* With collaboration

Marketing and Strategy

From the literature, it is also found that there is about 150% increase in number of organisations the worldover dealing with MMC during the last decade. Despite 'wait and see' policy to adopt any new material which exhibits improved performance and considering the infant nature of market for MMC, there are increasing commitments for major investments in R&D and prototypes. This is based on the world market demand for MMC with $ 37-69 m in 1993-94 which is expected to reach $ 229-436 m by 2000 AD at 20-25% AAGR (average annual growth rate).

Considering the above factors concerning MMC, status studies have been reported for developing planning strategy for MMC by various countries. One such report[10] was prepared by Overseas Science & Technology Expert Mission of UK after visiting Japan in 1986. The Mission was concerned with materials of relevance to prospective UK makers and users of MMC with focus on available and planned capability of industries to supply both the reinforcements and MMC as semi-finished products, components etc. The committee also looked at the national programme in promoting the developments of MMC technology and investigated the possibilities for technical collaboration between the UK and Japan. Important finding of this Mission was a high scale of industrial commitment to MMC related R&D in Japan with emphasis on automotive applications.

M/s Technical Insights Inc., New Jersey (USA) conducted a Delphi study[11] as a part of the 'Emerging Technologies' for the future to assess the MMC Technology in all aspects. The results revealed that despite significant strides made in developing MMC for general engineering applications, high impact would still continue to be in Defence, Space and other strategic areas. The study also revealed a mixed response even for automotive sector, wherein already MMC has been commercialized and prototypes are being developed and tested. However, it was opined that the rapid decrease in the cost of MMC would eliminate lingering fears regarding its diffusion. The study has also reported greater scope for Aluminium based metal matrix composites (AlMMC) for wide ranging applications.

The present Delphi study is conducted to identify topical areas of research interest in the area of MMC so as to enable R&D managers to perceive research priorities and potential research areas to be addressed to keep pace with the development of MMC abroad. The study has taken into account the research capabilities in India, particularly in AMMC, recently developed.

Delphi technique has been adopted for the study keeping in view its sequential nature, with feedback at each stage so as to arrive at consensus views. This approach would be very essential for a study of this nature with a large collection of possible areas and experts.

Methodology

The methodology used is based on literature on Delphi technique for similar applications[8-16]. It has also drawn from a similar study in Food Science & Technology area carried out by one of the authors[17]. It is well-known that quality of output of Delphi study depends on selection of experts, identification of topics, design of questions and its administration. Moreover, the success of such study depends on the cooperation of the experts in giving their response. Accordingly, for the present study, the panel of experts (41) were chosen from the academic, public sector, R&D, and industrial segments. In addition to the national experts, a group of six international experts were also chosen with the purpose of comparing their views with those of the national experts.

For the purpose of identification of topics in MMC to be included in the questionnaire, a detailed literature survey was carried out by scanning data for the last five years in reputed journals, like *Chemical Abstracts* and *Metal Abstracts*. At first level, about 200 topics were identified based on frequency of topics cited in the literature reflecting their potential and scope to a certain extent. Through personal discussions with some of the experts at a preliminary level, a first level screening was carried out. It was found that Al/ Al alloy based composites were the most commonly studied or being used MMC. Accordingly the topics were restricted to Al based composites and finally 45 relevant topics were selected for preparing the questionnaire. The topics were also selected from the findings of another Delphi study with a somewhat different focus[11].

The questionnaire was kept simple to enable easy understanding and response from experts.

Each questionnaire was designed to obtain information on both current status and future scope for each of the research topics on a ten point scale, in the form of ratings for comparative purposes. For 'Current Status' the zero point was considered as 'very poor', and tenth point was considered as 'highly developed'. Similarly, for 'Future Scope' the zero point was considered as 'irrelevant' and the tenth point as 'crucial importance'. The rating scale was normalized to reduce subjectivity in judgement scale with oral responses.

The questionnaire thus prepared was sent to the selected experts both in the country (41) and abroad (6). Of these, 25 (61%) responded from within the country and one from abroad.

Based on the analysis of the response received, another round of questionnaire was prepared similar to the first round and sent to those who had responded (25) for the first questionnaire. The set of questions in the second round had 31 questions selected, based on the value of median ratings for 'Current Status' and 'Future Scope' from the first round questionnaire. Questions which had a median value of 5.25 or above for 'Current Status' and 7.25 and below for 'Future Scope' were not selected as per the following reasoning:

Current Status — Median $\geq$ 5.25 — These are areas where competitive research work is going on but can be considered as reasonably developed and hence not a priority area as such for concentration by the researchers, so as to avoid duplication and cost of additional infrastructure as well as diffuse funding.

The logic of selecting areas with current status less than 5.25 is exactly to avoid areas in which R&D efforts have proceeded to such an extent that the presently engaged institutions themselves can put in mere concentrated efforts to arrive at saleable technologies. This, they would be attempting as a corollary of their development status. This Delphi study does not to include such 'Mature' areas in its ambit.

This is in line with the objective of this study to identify other areas of priority interest where R&D work can be mere effectively nucleated and where work has not proceeded to a high current status, so that institutions can initiate R&D work in the area of future potential and relatively lower current status in

order to avoid diffuse funding. This was the focus with which the above logic has been arrived at. This is very pertinent in selecting important area for work initiation and pursuit, particularly in regard to emerging areas with considerable future scope.

Future Scope — Median ≤ 7.25 — These areas do not promise the future potential, as far as MMC are concerned, despite their current status, It is advisable not to enhance the work on these areas, since these may not be of topical interest.

In order to provide feedback information from the first round, the ratings on responses as values of first quartile, median and third quartile were indicated for each question. Individual's responses of each expert to 'Current Status' and 'Future Scope' parts of the questions in the first round was shown with red tick mark on the questionnaire,. so as to give the feedback on their own rating providing a chance to change their earlier rating, if they found it necessary. This feedback is an essential part of the Delphi study, since the primary objective of Delphi is to reduce the inter-quartile range, while establishing the median more exactly, based on a sequential process of expert response. In the second round experts were requested to give reasons, in brief, for their responses. About 50% responses were received for the second round and 75% of them have revised their earlier ratings so as to conform more to the median feedback, thus establishing the Delphi objectives.

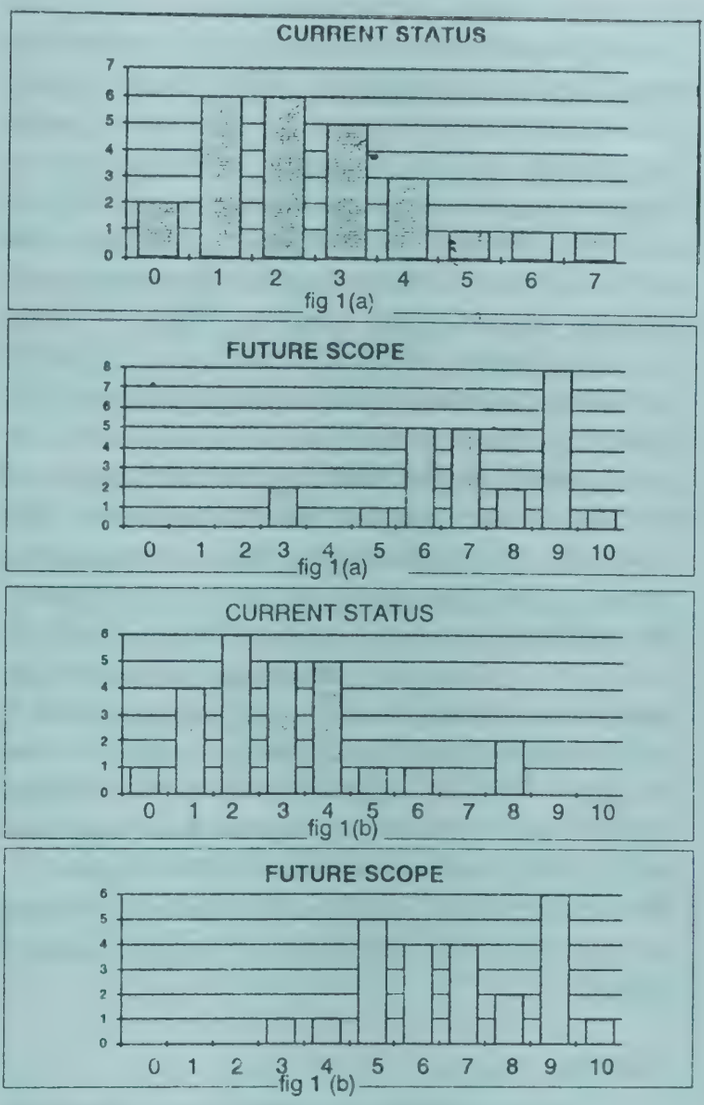

Fig. 1 — Application of advanced composites in gas turbine Aero engines

Analysis

For both the round of responses, first quartile (25th percentile), median (56th percentile) and the third quartile (75th percentile) were calculated for each part (i.e. current status and future scope). In the case of second round, revised ratings were used for calculations. Responses of the experts gave different reasons for their ratings including basis of their general awareness and experience or personal knowledge, acquired from different sources like literature, internal reports, experimental data, journals, and dissertations. Histograms were drawn separately for 'Current Status ' and Future Scope' for each questions to indicate distribution of answer for each question. A box and whisker plot was drawn below the corresponding histograms using the calculated quartile values with first quartile on left hand end, third quartile at the right hand end and the median by a vertical line inside the box. As is well known, histograms are usually indicated in Delphi studies and the Box-whisker plots given subsequently represent the quartile ranges and median. They are given together to facilitate identification of quartile bunching, which is essential for arriving at a Delphi outcome. The analysis was similar to an earlier study for S&T planning using Delphi in Food Science & Technology [18].

Results and Discussion

Figure 1 illustrates some typical histograms and boxes and whisker plots prepared, based on the analysis of responses received for different stages of

the questionnaire. The X-axis represents ratings and Y-axis gives the number of responses. Certain topics were found to be having low current status, wherein the infrastructure for research may be sparse. Despite the demerits, such as economical infeasibility to create necessary infrastructure to carry out research in such areas, they can be considered as futuristic areas and hence researchers can look into these areas as of potential interest in the long run. Thus, 14 topics whose median values for current status are below 2.5 and having considerable future potential as per expert rating have been selected as potential areas of research, based on (the median values and) degree of bunching of inter-quartile values of responses. This is because of the low status of infrastructure development at the present despite its future relevance. This will help to give a focus for efforts in infrastructure build-up, particularly since huge investments are involved in initiating work in such areas and there is a vital need to channelise the same, keeping in view the highly 'nascent' stage of development of these futuristic areas. Similar approaches have been successfully adopted as reported in related literature[12-17]. The areas/topics so identified are shown here along with the five areas identified as futuristic areas of research.

Promising Areas

1 Micro mechanics approach to characterize interfaces in MMC.

2 Studies on corrosion behaviour of MMC.

3 Solidification modelling — studies of Aluminium Particulate Composites.

4 Studies on the elevated temperature behaviour of particle reinforced AMMC.

5 Studies on effects of heat treatment on the mechanical properties of AMMC.

6 Aluminium Matrix Composites fabricated by Spray Co-deposition.

7 Manufacturing process of Al-Si Matrix Composites Performs reinforced by C- fibres.

8 Extrusion of Powder mixtures for the preparation of Carbon fibre reinforced AMMC.

9 Process of forging short fibre reinforced AMMC / MMC.

10 Compo-casting techniques for fabricating AMMC / MMC with ceramic particulates.

11 Fabrication of fully dense composite materials by SHS under pressurized reactive gas atmosphere.

12 Fabricability / machinability of AMMC.

13 HIP-ed particulates MMC for hard wearing applications.

14 Use of composite materials in reciprocating engines.

Futuristic Areas

1 Recycling of AMMC / MMC.

2 Studies on the joining / weldability of MMC / AMMC.

3 Die casting process for the production of MMC.

4 Investment casting of AMMC.

5 Pressure casting of AMMC / MMC.

Further, classifying all the above under three aspects of MMC Technology viz. basic research, Fabrication or Manufacturing Technology and Application of MMC, it was found that majority of promising topics came under Manufacturing Technology which is expected since future applications depend on the cost, and the feasibility of getting MMC in the desired shape which seemed to be major problems for the acceptance of MMC by industries for components production and product fabrication.

Finally, comparison of the analysis of the responses obtained in the country and their rating for the 'Current Status' and Future Scope' *vis-a-vis* as provided by the foreign experts, revealed that the latter was comparable while there were divisions on the 'Current Status' showing higher ratings for the international scenario. This is understandable due to the developments and situational differentials as obtained in advanced countries as well as wider awareness about the same.

Concluding Remarks

The study was well received by the experts as revealed through the comments from a few of them. The percentage of response was also satisfactory for a study of this nature. The areas of topical interest and future potential identified have been assessed by

the experts as showing considerable future scope and research priority. A few areas were particularly identified from this view point based on median values and inter-quartiles of expert responses. A few of the experts also supported the conclusion so drawn as revealed through their comments in the second round. Of course, the study has made use of a combination of heuristic and semi - empirical methods in addition to the Delphi in designing the questionnaire and arriving at the conclusions[13,14]. Through such an approach the above Delphi has emerged as an effective tool in identifying important areas of research interest in the area of MMC for a developing country like India keeping in view its situational specifics.

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Preparation and Evaluation of a Refreshing Sugarcane Juice Beverages

S K Chauhan*, V K Joshi and B B Lal

Department of Post Harvest Technology, Dr Y S Parmar University of Horticulture & Forestry, Solan 173 230 (HP), India

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Studies on the preparation and evaluation of sugarcane juice beverages with the combination of ginger, mint, and lemon extracts were carried out. The 0.5 % lemon juice was found to be optimum for maximum juice yield. Six combinations were screened out through preliminary studies on the basis of sensory evaluation characteristics. The products were analyzed for physico-chemical and sensory characteristics. The titratable acidity, colour units, and ascorbic acid were increased while total ash, pH, and red colour units were moderately decreased with the addition of increased proportion of ingredients in sugarcane juice.The treatment (T_2) was adjudged best being a maximum sensory score. The best product showed over six months storability without any change of constituents.

Introduction

The sugarcane juice due to its refreshing, high medicinal properties and calorific values is very popular in India. It is considered useful against jaundice, typhoid, and other related diseases. The sugarcane juice is an inexpensive and pleasing beverage and is available in abundance in India. Normally, fresh sugarcane juice blended with lemon and salt is useful as a drink during summers. Although efforts have been made by several workers to retain the colour, flavour and taste of sugarcane juice[1-3] but the originality or natural form of products has been seriously affected as compared to fresh juice. Therefore, the aim of study was to prepare and evaluate new refreshing sugarcane juice beverages with various optimized levels of ginger,lemon, and mint extracts and to see the effects of these optimum levels of ingredients on physico-chemical and sensory characteristics of sugarcane juice beverages.

Material and Methods

The fresh sugarcane juice was obtained from the market. The juice was filtered through double layered muslin cloth after setting of suspended cellulosic materials. The other ingredients, viz. ginger, lemon, and mint were procured from local market/University orchard and their juices were extracted as per the conventional methods. The proximate composition of respected juices has been given in Table 1.

For clarification of extracted juice, the enzymatic as well as chemical extraction were carried out by the addition of 0.05 % citric acid, 0.5 % lemon juice or pectinol(Table 2). There were nineteen combinations

Table 1 — Proximate composition of sugarcane juice, lemon, ginger juice and mint extract

Characteristics	Sugarcane juice	Lemon juice	Ginger juice	Mint extract
Moisture Content, %	78.00	84.00	80.20	84.10
TSS, ^{0}Brix	25.00	10.00	11.50	7.00
Titratable acidity, % CA	0.116	4.95	0.09	0.105
pH	6.85	2.32	6.45	6.10
Total sugar/carbohydrates, %	16.20	9.27	11.10	5.50
Reducing sugar, %	8.09	7.17	—	—
Total ash, %	0.99	0.99	1.19	0.90
Ascorbic acid, mg/100ml	0.49	43.0	10.00	28.20

*Address for correspondence : D-164, Prem Nagar, Line Par, Moradabad 244 001 (UP), India

Table 2 — Effect of addition of clarifying agents on the physical quality of sugarcane juice

Treatments	TSS (^{0}B)	Juice yield (%)	Acidity (% CA)	pH	Flow time (s)	Colour	Overall acceptance
T_1 0.05, % Citric acid	25.2	88.0	0.574	3.56	2.2	Reddish yellow	Very good
T_2 0.50, % Lemon juice	25.1	89.0	0.417	3.76	1.8	Reddish yellow	Very good
T_3 0.50, % Pectinol	25.0	86.5	0.140	5.59	2.1	Greenish yellow	Slightly acceptable
T_4 Control	25.0	79.0	0.128	5.87	2.0	Dull greenish	Slightly good

Table 3 — Different combinations of juice with other ingredients for ready to serve beverages

Treatments	SCJ (%)	GJ (%)	LJ (%)	ME (%)	Colour (%)	Water (%)	TSS (^{0}B)	Sensory score (9)
T_1 as such	60	—	—	—	—	35	18.0	5.0
T_2 as such	60	—	—	—	0.200	35	18.0	5.00
T_3 filtered 60	—	—	—	—	35	18.0	5.00	
T_4 filtered 60	—	—	—	0.200	35	18.0	6.00	
T_5	60	0.5	0.5	0.2	—	35	17.5	6.50
T_6	60	0.5	0.5	0.2	0.250	35	18.0	6.50
T_7	60	1.0	1.0	0.3	0.175	35	18.0	6.50
T_8	60	1.5	1.5	0.3	0.100	35	18.0	7.00
T_9	60	2.0	2.0	0.4	0.125	35	18.0	7.00
T_{10}	60	2.0	2.5	0.4	0.150	35	18.0	7.00
T_{11}	60	2.0	3.0	0.4	0.175	35	17.5	7.50
T_{12}	55	2.0	2.5	0.4	0.200	40	16.0	8.50
T_{13}	55	2.0	3.0	0.4	0.225	40	16.0	7.50
T_{14}	50	2.0	2.5	0.4	0.250	45	14.0	7.00
T_{15}	50	2.0	3.0	0.4	0.275	45	14.0	6.00
T_{16}	65	2.0	2.5	0.4	0.300	30	21.0	6.00
T_{17}	65	2.0	2.5	0.4	0.325	30	20.0	5.00
T_{18}	45	2.0	2.5	0.4	0.350	50	12.0	5.00
T_{19}	45	2.0	3.0	0.4	0.375	50	12.0	4.50
CD at 0.05	—	—	—	—	—	—	—	1.49

SCJ: Sugarcane juice, GJ: Ginger juice, LJ: Lemon juice, ME: Mint extract

(Table 3) of sugarcane juice with or without other ingredients, viz. ginger, lemon, mint extract, and colour were tried. After mixing of optional ingredients, the rest of the procedure was followed as per the method outlined for beverages preparations or processing purpose[4].

Out of the 19 combination, six best combinations were screened out on the basis of sensory evaluation and these optimized combinations were analyzed for physico-chemical characteristics, viz. TSS (^{0}B), pH, acidity (as % CA), ash, colour units, sugar, ascorbic acid contents as per the standard methods[5]. Sensory analysis was carried out by a panel of 15 judges, the coded samples were presented in random order to the panelists and their responses were recorded on the prescribed pro forma on weighed attributes for comparing the sensory qualities as reported[6-7]. All the

determinations were made in triplicate and means are reported in the literature.

Results and Discussion

Table 1 reveals that the fresh sugarcane juice has good source of total sugar, reducing sugar as also supported[3],lemon juice,ginger, and mint extract are a good source of carbohydrates, ascorbic acid which contributed for refreshing as well as nourishing beverages along with sugarcane juice[8]. Table 2 reveals that on the basis of per cent juice yield and overall acceptance, the treatment T_2 is found to be the best over the others. Though, addition of Pectinol Enzyme also increased the recovery of juice but was rated slightly acceptable. The treatment (T_2) being of maximum sensory scores can be used for blending purpose. Table 3 shows the various combinations of ingredients tried and on the basis of sensory evaluation the treatments T_{11},T_{12},T_{13},T_{14},T_{15} were adjudged best. These screened combinations were evaluated along with control (T_1) sample. From Table 4, it is revealed that with the increased proportion of ingredients,the titratable acidity, colour, and ascorbic acid were increased while total ash, pH, and red colour unit slightly decreased. These changes may be attributed to the addition of ginger, lemon, and mint in sugarcane juice as reported earlier[3].

On the basis of sensory evaluation (Table 4), it can be concluded that the addition of ingredients to sugarcane juice for beverages, improved the taste, colour, flavour, and the quality of the finished products. Only there was slight colour change from green to dull yellow orange. It may be due to the changes of pH in juice by the addition of ingredients, partly enzymatic as well as due to the effect of metal crusher used but this colour change could be avoided by the addition of permitted green colour 0.02 % under the Fruit Product Order (1954) Act[5]. To maintain the originality of the product the permitted green colour @ 1ml diluted 100 ml and from 100ml @ 0.05 to 0.35% was added to the juices. Therefore, (T_{12}) was adjudged best over the other treatments.

Table 4 — Physico-chemical and sensory evaluation of selected sugarcane juice beverages

	Treatments						
Physico-chemical characteristics	T_1	T_{11}	T_{12}	T_{13}	T_{14}	T_{15}	
TSS ^{0}Brix	18.00	17.20	16.40	16.00	14.20	14.20	
Acidity as % CA	0.16	0.19	0.25	0.22	0.21	0.30	
pH	4.75	3.60	3.40	3.50	3.18	3.08	
colour unit R	3.40	3.50	2.50	2.90	1.60	2.50	
Y	10.5	11.5	15.20	12.80	10.80	12.50	
B	0.70	2.70	0.20	0.30	0.20	1.00	
Total Ash (%)	0.99	0.96	0.97	0.98	0.96	0.97	
Ascorbic acid (mg/100 ml)	0.275	0.375	0.540	0.500	0.375	0.450	
Reducing sugar (%)	8.00	5.00	6.00	8.00	5.00	5.00	
Total sugar (%)	13.40	15.30	14.70	14.30	13.30	13.00	
Sensory attributes							CD at 5 %
Colour (20)	11.67	13.00	15.00	14.00	13.33	14.30	0.52
Flavour (20)	12.00	13.33	16.33	13.67	14.33	14.60	0.65
Consistency (20)	11.33	12.67	15.33	13.67	15.67	15.00	0.96
Taste (20)	12.67	12.33	16.33	13.33	13.67	16.00	1.60
Overall quality	11.67	12.00	16.33	13.33	14.67	15.00	0.46
Total score (100)	59.34	63.33	79.32	68.00	71.67	75.00	5.12

Table 5 — Chemical and sensory changes of best treatment (T_{12}) during storage at RT

Storage period (months)	Storage temperature	Titratable acidity (%)	pH	Ascorbic acid (mg/100ml)	Total sugar (%)	Sensory scores (9)
Initial	—	0.25	3.40	0.500	14.30	8.00
3	RT*	0.25	3.40	0.500	14.20	8.00
6	RT	0.25	3.40	0.500	14.20	8.00
9	RT	0.24	3.52	0.390	14.20	7.00
12	RT	0.24	3.55	0.300	14.20	7.00

*RT: Room temperature (18-30°C)

From storage studies (Table 5), it is revealed that the product has good storability. There were no significant changes in nutritional as well as sensory qualities of the product even for more than six months at ambient temperature.

The sample was rated very good with respect to taste, flavour, colour, overall quality up to six months of storage. Beyond the said period, slight flavour loss of mint, ginger, sugarcane juice was observed, although the product was rated good up to the 12 months of storage. The best product (T_2) was screened out through consumers preference test and it was opined that about 70% very good, 20% good,and 10% slight acceptable. Thus, it can be easily concluded that the finished product had good acceptability and could be commercially exploited .

It is thus evident from the studies that the product could be processed, bottled, stored even for six months without altering so much qualities and the product is a good source of nutrient ,with high calorific value and good palatability.

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Infrared Absorption Spectra of Recycled Paper

El Sayed M A Khalil*, O Y Mansour**, M A Nassar** and El Meligi MG**

*Spectroscopy Department, Physics Division, National Research Centre, Dokki, Giza, Cairo, Egypt

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Infrared (IR) spectra of recycled newsprint, writing and printing paper were recorded at 200-4000 cm^{-1}. The fine structure of the unbleached and bleached recycled pulps was investigated. The purpose of bleaching processes was the removal of colouring materials in the recycled paper and the production of white pulps with satisfactory physical and chemical properties. Therefore, different pulps of recycled paper were prepared to obtain new product of paper in two stages. The first stage being the treatment by detergent at 70°C for 45 min and pH 9 to obtain pulp used for making paper board. In the second stage the pulps were treated with H_2O_2 at 70 °C for 45 min which gave pulp for making white paper. The chemical analysis of the wastepaper showed increased contents of α-cellulose after recycling and decreased contents of lignin and hemicellulose. The lead ppm decreased after treatments to obtain safe paper board used for packaging. The characteristic band spectra of the pulp were not affected by the process of the treatment. The characteristic band for the hydrocarbon resin was absent. The ink did not react with the pulp composition.

Introduction

The recycling of the wastepaper is being studied worldover because of the high cost of all types of paper and for minimizing pollution. Recent research on waste paper recycling has been substantially directed towards technologies of the ink removal. Several methods have been applied in the past to remove ink particles from fibre surfaces which include : mechanical shearing[1] ; ultrasonic methods[2], thermal effects[3], chemical actions including the use of selective solvents[4] , and more recently, the use of special additives, like the FOAD surfactant[5], with custom-designed hydrophobic-liophilic balance (HLB) values. It is well known that complete removal of ink particles without damaging the fibre has not been studied so far, while the wash and the flotation deinking processes are found to be individually very effective. For a specific size range of deinking particles a combination of these techniques is currently being employed to achieve maximum effectiveness. Apparently, none of these deinking methods consider the underlying mechanism of ink deposition on a paper surface during printing operations. Earlier works on water paper deinking did not give much importance to the understanding of the mechanism of various possible interactions between the substrate and the ink vehicles. Waste papers, such as pre-used writing, printing and newsprint can be recycled in the form of board without deinking. The resulting board is not safe because of the contents of the ink. Therefore deinking of waste paper is essential before making board. The deinking was done under alkaline condition, this assists in the saponification of the ink vehicle, thereby assisting in the loosening of the ink from the fibres[6]. The analysis of deinked papers showed significant decrease of lead, i.e., less than 0.5 ppm, for safety for its use as board in packaging[6]. Addition of starch and sodium silicate to the deinked waste paper increased the mechanical properties of the board.

The aim of this work is to use one of the detergents to remove the ink from the newsprint papers and other writing and printing papers. These pulps were further processed as board[6]. The unbleached and bleached pulps produced from these waste papers were analyzed for the IR spectra.

**Cellulose and Paper Department

Materials and Methods

Recycling of Waste Papers

The waste papers used here were newsprint, writing, printing, and blend of the three papers in equal percentages. Each sample was cut into small pieces and soaked in warm water (45 to 50°C) for at least 4 hr. The soaked waste paper was beaten for making pulp. The re-pulped pulp was treated with 3% detergent, and 2% sodium silicate (or 2% sodium hydroxide), based on dry weight of re- pulping pulp at 70°C for 30 min for newsprint, and 20 min for printing, writing, and for blend . The bleached pulp was also washed properly. Analysis of the pulps for α- cellulose, hemicellulose, lignin and ash was carried out.

IR Absorption Spectra

Samples were grounded by using agate mortar, different grain sizes of the samples were obtained by sieving the ground pulp using ASTME 11.39 Series. Samples were dried at 100°C, the best conditions used in this work were constant throughout this study and are as follows:

For the Sample Disc

Weight of sample 2 mg, weight of KBr 198 mg. Total weight of specimen disc 200 mg, pressing time 2 min, grain size of the sample 44-37 μm, vacuum forming pressure 5 tonne/cm^2, thickness of the specimen disk 1.25 mm.

For the Reference Disc

Weight of spec pure grad KBr 200 mg, grain size 44-37 μm, vacuum forming pressure 5 tonne/cm^2, thickness of reference disc 1.25 mm, pressing time under vacuum 2 min

The instrumental used in this work was the Jasco FT/IR 300E, IR Spectrometer Fourier Transform, Japan, double beam IR Spectrophotometer throughout the measurements.

Results And Discussion

Chemical Analysis of Waste Paper

Newsprint, writing and printing papers were chemically analyzed for α- cellulose, hemicellulose, and lignin, as shown in Table 1, the α-cellulose content was high in writing and printing papers compared with the newsprint. Deinking of these waste papers increased the α- cellulose and decreased the lignin and hemicellulose contents. The lead content of the treated pulps decreased from 10 ppm to 0.65 ppm, from 2 to 0.85, and from 6 to 1.1 for writing, newsprint, and printing paper, respectively. The decreased values of lead content were within the safety value, which is less than 0.9 ppm in most cases as indicated by atomic mass spectra.

IR Absorption Spectra

The main objective of the deinking process is the removal of the colouring materials in the fibre and the production of a white pulp having satisfactory physical and chemical properties. The molecular structure of cellulose and softwood lignin shows that the cellulose molecule is composed of a series of glucose units. These glucose units are linked together by oxygen bonds, the cellulose molecule thus comprises long straight chains of glucose anhydride units arranged in cellobiose pairs. The alcoholic group in the cellulose molecule undergoes alcoholic reaction, such as esterification, oxidation, and alcoholate formation. In addition to alcoholic groups, there are also some carboxyl groups which are a few in number.

Table 1 — Analysis of pulp

Experiment	Waste papers			Deinked waste papers		
	Newsprint	Writing paper	Printing paper	Newsprint	Writing paper	Printing paper
α-Cellulose, %	58.60	71.60	68.20	60.00	73.00	70.00
Hemicellulose, %	11.20	18.80	19.40	09.30	18.00,18.50	
Lignin, %	28.80	3.34	4.60	27.50	2.60	3.40
Ash, %	1.40	6.00	8.00	1.28	5.40	7.20
Lead ppm	2.00	10.00	6.00	0.85	0.65	1.10

Table 2 illustrates the IR spectra of newsprint, printing, writing and blend papers before treating and after deinking. The IR spectra were first recorded for the waste papers of the three pulp modes and for the mixture of the different chosen pulps modes, which is the blend pulp, and which is the first step of treatment by detergent, second step of treatment was by hydrogen peroxide. The characteristics bands spectra were interpreted as follow :

1 IR absorption band at 900 cm^{-1} corresponds to - $CH = CH_2$ and $= C = CH_2$ bending vibrations which are characteristic of cellulose and lignin molecules.

2 IR absorption bands at 1015-1030 and 1060 cm^{-1} are due to the presence of methoxyl groups which are the characteristics groups of lignin and are found in all samples

3 IR absorption band at 1110-1115 cm^{-1} and 1280-1285 are attributed to - CH_3 group. The methyl group at 1110-1125 cm^{-1} is found in all samples, while CH_3 at 1280 cm^{-1} is absent in all samples.

4 IR absorption band at 1160-1180 cm^{-1} confirmed $-\overset{|}{\underset{|}{C}}-O$ structural unit.

5 IR absorption bands in the interval 1300-1500 cm^{-1} are attributed to aromatic C-H and CH_2 in methyl or methylene groups and are found in all cases.

6 IR absorption bands at 1600-1800 cm^{-1} are for $RCOO^{-}$, C=C and C =O groups which confirmed the carboxyl contents COO^{-}, C =C of aromatic ring and C =O indicated the presence of saturated ketone of cellulose units, which absorbs in this range arising from carboxyl groups, respectively.

7 IR absorption band at 2340 cm^{-1} is for =C =O group.

8 IR absorption bands at 2350-2360, and 2370-2380 cm^{-1} are due to O-H bonded stretching vibrations of bonded hydroxyl group of cellulose and lignin.

9 IR absorption band at 2850 cm^{-1} indicated the appearance of -CH_2 groups which is in all samples except for the blend.

10 IR absorption bands at 2900-2920 cm^{-1} confirmed C-H stretching vibration of -CH_3 groups and this was found in all samples.

11 IR absorption band at 3400-3421 cm^{-1} is due to O-H stretching vibration intra-bonded.

The treatment process did not affect characteristics band spectra of the pulp. The IR absorption spectra was used to check the pulp network structure, mainly small frequency shift for the mixture (blend) pulp to lower frequency after deinking, at frequencies 900-1180, which indicated that the strength of the characteristics bonds of the waste paper decreased due to detergent and hydrogen peroxide treatment. Also from the IR spectra, it is evident that the network structure of the different pulps are the same before and after deinking where the ratio of the ink is very small, which is found as trace material and did not interact as complexes within the network structure of the pulps.

The ink did not react with pulp composition, when added as adhesive material on the surface of the paper. The ink is an oil mineral constituent with small ratio of lead. The IR absorption bands at 1060-1080 cm^{-1} indicates the presence of Si-O bending vibration of SiO_4 tetrahedra of the added white kaolinite clay mineral of the bleached pulps composition[7] or may be due to the effect of the chemical on pulps by sodium silicate and the ink chemical compositions, where it contains mineral constituents within the oil composition of the ink. The fractions of structural groups, e.g., methyl, methelene, hydroxyl, carboxyl and alcoholic groups present in cellulose and lignin unit were indicated in the IR spectra of the different groups and produced pulps of waste paper for different industrial purposes.

It is worth mentioning that the characteristics band at 710 cm^{-1} assigned for a hydrocarbon resin[8] was absent for all samples. The broad band at 3351 cm^{-1} attributed to associated water molecules[9] was also absent. Strong band at 1029 cm^{-1} shifted in these spectra to 1025 cm^{-1} suggested that styrene is associated with the soluble part of the ink component[8].

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Table 2 — Infrared absorption spectra of different waste paper

Wavenumber (Cm^{-1})											Assignment
Blend of pulps			Writing paper pulp			Printing paper pulp			Newsprint paper pulp		
1	2	3	1	2	3	1	2	3	1	2	3	
900 VS	900	900	900	900	900	910	910	900	900	900	900	-CH=CH_2 and C =CH_2
1025 S	1030	1015	1025	1025	1025	1025	1025	1025	1025	1025	1025	CH_3 - O
1080 S	1060	1060	1060	1060	1060	1060	1060	1060	1080	1060	1060	CH_3 - O Si - O
1115 M	1110	1110	1115	1115	1110	1110	1110	1110	1115	1110	1110	CH_3
1180 M	1160	1160	1180	1180	1180	1180	—	1180	1180	1160	1160	- C-O-
1280 W	1280	—	—	—	—	—	—	—	1285	—	—	CH_3
1300	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300	CH_2, C-H bend Vibr
↓ W	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	
1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	RCOO C =C and C =O
↓ W	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
1730	1730	1730	1730	1730	1730	1730	1730	1730	1800	1800	1800	
2340 VW	2340	2340	2340	2340	2340	2340	—	2340	2340	2340	2340	=C =O
2350 VW	2350	2350	—	—	—	—	—	—	2360	2360	2360	O - H bonded Str Vibr
2370 VW	2370	2370	2380	2380	2380	2380	—	2380	—	—	—	O - H bonded Str Vibr
2850 Sh.	2850	2850	—	—	—	—	—	—	—	—	—	- CH_2
2920 S	2920	2920	2920	2920	2900	2900	2900	2900	2920	2920	2920	C -H Str Vibr of CH_3
3421 VVS	3421	3410	3410	3410	3400	3400	3400	3400	3400	3410	3400	O - H Str Vibr Intra bonded

1 — Without treatment, 2 — Treatment by detergent at 60 °C 3 — Treatment by hydrogen peroxide at 60 °C
Sh =Shoulder, VW =Very weak, W =Weak, M =Medium, S =Strong, VS =Very strong, VVS =Very very strong

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CONFERENCE REPORT

Tenth National Conference on In-house R&D in Industry

V V Subba Rao

Department of Scientific and Industrial Research, Ministry of Science and Technology,
New Mehrauli Road, New Delhi 110016

Inaugural Session

Attended by over 500 participants from Industry, Government, National Laboratories, IITs, Universities, Consultancy Organisations, and other Institutions, the Tenth National Conference on In-house R&D in Industry was inaugurated by Prof. Y.K. Alagh, Union Minister of State (Independent Charge) for Planning & Programme Implementation and Science & Technology, in the morning of 10th December, 1996 at New Delhi. He congratulated DSIR and FICCI for their continued relationship in organising this important national conference and also continued efforts towards strengthening domestic technological capabilities in Industry, and hoped the same to continue on stronger footing in future too. He also congratulated the seven national award winners for their outstanding achievements in R&D. The award winners included (i) Armour Polymers Limited, Mumbai, (ii) Hetero Drugs Ltd., Hyderabad, (iii) Lamco Lightning Arrester Mfg. Company Pvt. Ltd., Hyderabad, (iv) Patwa Kinarivala Electronics Ltd., Vadodara, (v) Titan Industries Ltd. Hosur, (vi) Ankur Seeds Pvt. Ltd., Nagpur and (vii) Jain Irrigation Systems Ltd., Jalgaon. The Minister gave away the awards (Silver Shields) to the winners.

The Minister expressed his happiness that the national award winners represented different sectors of economy and industry which were very important in national development. He hoped that the industry would be able to provide better and more competitive products and services to the public including the farmers, with strengthening of their technological capabilities.

The Minister further said that the theme of the present conference, i.e. Technical Consultancy - Lever for Innovation, is extremely important and timely, particularly in the context of flexible technologies. He desired the integration of different disciplines and use of knowledge for deliveries from innovation to production. He also emphasised the need to strengthen domestic skills to intelligently acquire technologies and knowledge from outside. Outlining the importance and role of small and medium enterprises in our economic and industrial development, the Minister desired them to strengthen their technological capabilities to meet the emerging challenges. He further advised that there should be synergy between industry, R & D system, academic institutions and other players related to technology.

Prof. Y.K. Alagh urged Indian industrialists to take full advantage of Technology Development Fund created by the Union Government for developing innovative technologies if it is to compete in the global markets. He also called upon the industry to take advantage of the Government support that was coming in the form of direct and indirect financial support and other measures.

Prof. Alagh has also emphasised the need to develop skills and acquire technologies and knowledge from the outside world. Industry has to take appropriate initiatives towards this endeavour. the Finance Ministry was fully supportive in raising the resources for R&D and to make investments in R&D more attractive. He also emphasised on the urgent need for integrating various systems namely R&D system in industry and university system to make faster technological advancements in the country. There is an urgent need for developing skills and to convert the innovations into productive processes more efficiently and effectively.

Prof. Alagh further outlined the importance of small and medium enterprises in the industrial development of the country and urged them to take appropriate measures to raise the overall technological levels and capabilities.

Dr. R.A. Mashelkar, Secretary, DSIR and D.G., CSIR in his address briefly reviewed the decade of activities of DSIR mainly relating to Promotion of In-house R&D in Industry, Technology Absorption, Technology Transfer and Technology Management. He also outlined the role of DSIR in strengthening the linkages and interfaces between Government, Industry, R&D Institutions, Consultants and other related organisations. Energy conservation, globalisation of R&D, new Intellectual Property Regime, etc. were highlighted as some of the important areas for R&D. He said that DSIR has given 81 awards so far; this year there are only 7 award winners while last year there were 15. This indicates that DSIR has tightened its standards and norms in line with the stricter requirements of quality and levels of technology in the industrial sector.

Dr. Mashelkar emphasised the role of DSIR in strengthening partnerships between the national laboratories and industry through its PATSER Scheme which provides financial support to Industry for Technology Development Projects. He also outlined the role of Technology Development Board and the enthusiasm and expectations of industry from this Board.

Dr. Mashelkar briefly outlined the various fiscal incentives and support measures available to industry for development and promotion of technology. He also mentioned about the new incentives such as five year tax holiday to commercial R&D companies, exercise duty waiver for goods produced based on indigenously developed technologies duly patented abroad, and custom duty waiver on goods imported for executing government- funded R&D projects in DSIR recognized in-house R&D centres in industry. He also mentioned about the simplification of the procedures for 125% weighted tax deduction for investment in R&D by industry. He said that the concerned institutions are now authorised to certify and the industry need not come to DSIR. He also said that the requirement of additional incentives could also be examined provided the mechanisms are transparent.

Appreciating the role of Technical Consultancy as Lever for Innovation which is the theme of the present conference, Dr. Mashelkar said that there is a great potential for utilising the knowledge and expertise available in R&D institutions, academic institutions, and consultancy organisations and elsewhere, for expeditious and economically beneficial development of technologies. He also said that there is a great potential for export of our technical consultancy services, and cited the illustration of National Chemical Laboratory which won an international contract from China in 1990. Dr. Mashelkar also appreciated the role being played by DSIR and its Consultancy Development Centre towards nurturing and development of technical consultancy in the country.

Dr. Mashelkar advised that the untapped knowledge and expertise available in various R&D organisations and academic institutions should be utilized by the industry, and the industry should break away from the mental barriers, to compete globally.

Shri Aditya Trivedi, Deputy Secretary of FICCI welcomed the delegates and expressed apologies on behalf of Shri Deepak Banker, President, FICCI for his inability to be present in the inaugural session of the Conference.

Session-I: Presentation of Achievements by Award Winning Companies.

The Session was chaired by Dr. R.A. Mashelkar, Secretary, DSIR and Director General, CSIR. All the 7 award winning companies made technical presentations of the award winning achievements. At the end of the presentations, the Chairman made very important observations for consideration by industry, government and R&D institutions.

He observed that the National Awards for Outstanding In-house R&D Achievements were instituted by DSIR in 1987 and implemented since 1988. With this year's awards, 88 companies have bagged the DSIR awards. Dr. Mashelkar suggested that DSIR should bring out a study report of what happened to the award winners during the past 9 years; how many companies survived; how many companies improved their technologies; how many companies produced exportable goods. He suggested that we have to talk on sustainability of R&D and the report should highlight on decade of excellence of R&D in industry.

Dr. Mashelkar further talked on the investments in R&D by industry. He observed that about 20 years ago Korea was exactly in a similar position as India today in terms of R&D in industry. Korean industry's contribution to the R&D was around 20% in terms of expenditure and the rest of 80% was by the Government. But the trend has reversed and now 80% of the investments are made by the industry and only 20% by the Government. He said that we have to learn lessons from the Korean experiences on how this ratio has changed. He also observed that we looked at the Government for support for too long. He further stated that the role of the government is changing and we have to look at the new relationships between the government and industry from the R&D point of view. Industry should take a larger share of responsibility for making investments in R&D and Government, of course, will support core R&D programmes and basic research, and the central stage should be with industry.

Dr. Mashelkar observed that DSIR funding schemes such as PATSER, the Technology Development Fund of DST, should be increasingly utilised by industry. He also advised industry to come with specific R&D programmes with clear goals so that DSIR will be able to support such programmes increasingly.

Dr. Mashelkar highlighted that CSIR has a vast network of 40 laboratories with 26,000 personnel. CSIR system is getting energized and CSIR has set tough targets for the year 2001, both in qualitative and quantitative terms and in terms of export of technologies and earnings from external sources. He also highlighted that CSIR is giving greater importance and thrust to customer satisfaction and CSIR customers are medium, small and large industries. The CSIR laboratories have become national reservoirs of excellence and CSIR is striving towards reaching greater heights. At the same time, networking of industry with the CSIR laboratories is very essential and called for concerted efforts on the part of the industry.

Dr. Mashelkar mentioned that at one time DSIR had an award for Export of R&D based Technologies but this was discontinued as there was no applicant from industry continuously for two years. We have to now fulfill the dream of the country of exporting technologies not only to the least developed and developing countries but also to most technologically advanced countries such as in Europe and USA. We should also aim at not only exporting goods and services but should take real advantage of the knowledge base and knowledge should add to the value of our R&D and exports. He suggested DSIR to reintroduce a National Award for Export of R&D based technologies.

Session-II: Technical Consultancy in Manufacturing Industry

The session was chaired by Shri Ashok Parthasarathi, Secretary, MNES. There were six presentations in the session.

Shri T.V. Balakrishnan, Director, DCL, New Delhi who has spent a number of years spearheading the electrical R&D projects at BHEL, delineated the experiences of BHEL in commissioning a number of projects related to the electrical sector. He mentioned that, excluding smaller fittings, the turnover of the electrical industry is of the order of Rs. 8000 crores per annum, which is being largely met by BHEL. The company consolidated its position as a major player in this sector, because it could harness the strength of its manpower and resources effectively through the application of appropriate consultancy techniques and management strategies. He mentioned that before a power system can be commissioned, several factors need be considered such as economic feasibility, site selection, plant conceptual design, bid evaluation, specifications finalization and project management. The company had set a vision of growing into a world class innovative, competitive, profitable enterprise, geared towards meeting commitments and excelling in performance. With this in mind, a chain of sophisticated laboratories in specialized areas were established in their corporate R&D set-up. This apart, their engineers and executives closely interacted with technologists from IITs, CSIR laboratories and CPRI on a one-to-one basis, to aid in the development of state-of-the-art equipment in the power sector.

Shri R.V.S. Mony, Executive Director, FEDO, Udyogamandal, Kerala explained the role of technical consultancy in enhancing R&D in industry. While redefining the role of R&D in the new economic situation, he mentioned that the Indian manufacturing sector has several challenges before it. The conventional role of consultants is in helping indus-

try reorganize itself and better its prospects by providing aid in areas such as identification of new opportunities, turnkey contracting, technology advisory services and feasibility studies. He suggested that both technical consultancy and R&D in an organisation need be fused, and the amalgamated unit can then play a nodal role in fostering innovation and technological development in an organisation. This unit can effectively act as an interface to strengthen linkages between national R&D institutions, foreign technology suppliers, academic institutes and industry. To discharge such a role, the existing consultancy organisations would need extensive re- capitalisation in terms of financial and human resource base. They would also need to focus on strategic management factors such as technology forecasting, technological change and know- why, to enhance R&D.

Dr. L.K. Singhal, Chairman & Managing Director, MECON, Ranchi, while describing some successful experiences of his company as a consultancy organisation, brought out the strategies adopted by his organisation. The consultant plays an important role as a facilitator to give shape to an idea with the appropriate perspectives in view. The company has pioneered the commissioning of varied kinds of sophisticated engineering equipment. As a consultancy organisation, they have worked in close cooperation with the companies seeking their services. They have, in addition, closely interacted with national R&D laboratories and academic institutions on several large projects. He cited examples of improved version indigenised coke oven batteries set up in Hindustan Steel in close association with their engineers, establishment of a pilot plant for recovery of magnesium and chlorine in a titanium sponge plant in close association with DMRL, CMRI, IGCAR, the setting up a plant for development of pitch bonded dolomite in association with SAIL R&D Centre, and others. The importance of interacting closely with the customer leading to successful innovation and enhanced creativity was stressed by him. He suggested that the government may consider partial financing of indigenous technological development efforts by consultancy organisations.

Shri Umesh Srivastava, Managing Director, HOLTEC Engineers Pvt. Ltd., New Delhi stressed the need for specialisation and multi functional networking in the current scenario. While mentioning that knowledge is critical for success, institutionalized expertise can be channelized through integrated consultancy services, he said. He suggested that engineering and management consultancy services need be integrated for this purpose. To elucidate this further, he explained the five M-s suggested by Mr. Ishikawa of Japan for problem analysis i.e. viz. Milieu- change in application, customer segmentation, increased competition; Materials - transition in usage of raw materials, data-building; Machines - new machines and technology for manufacturing sector, extensive use of computers; Man - lesser deployment of staff in manufacturing plants, need for augmenting expertise and experience; Methods - increase in outsourcing, reduced redundancy, greater responsiveness. To this, he added another area of importance i.e. Money involving multi sourcing, multi funding, need for quantifying benefits and management of capital. He also exhorted consultancy organisations to take adequate steps for continual knowledge and information updation of the latest technologies in consonance with international standards.

Shri P.V. Narayanan, Director, Indian Institute of Packaging, Mumbai brought out several strategies adopted by his institute to operate effectively as a consultancy organisation interfacing between the packaging industry and its users. In this context, he explained that the packaging industry is growing in leaps and bounds, in tune with the varied and increasing requirements of packaging a variety of goods. This industry is largely concentrated in the small scale sector. Packaging material are distributed between two sectors i.e. the primary sector involving paper and paper boards, glass, plastic, textile, jute, laminates and such others; and ancillary sectors involving items like adhesives, labels, inks, varnishes, and lacquers. While selecting plant and machinery for such varied requirements, different aspects such as material selection, package form, storage needs and machinability are considered. Important quality control aspects and developments in respect of improved material and improved processes are also kept in view. The institute has kept tune with such requirements on a continual basis.

Shri R.R. Hirwani, Head, Research Planning and Business Development, National Chemical Laboratory, Pune expressed the need for creating a Manufacturing Extension Centre together with regional

centres in the country, to deliver consultancy services to small scale manufacturers. He expressed that such a facility would provide a great fillip to the small scale sector in enhancing their creativity, innovativeness and their technology development capabilities. To elucidate this, he drew upon his experiences in the National Institute of Skills and Training (NIST) of USA, which provides such services. The Centres provide national access to services such as technological resources, network communications, standards for start up/operations apart from provision of a uniform national evaluation system. The extension centres assess the needs of the industry and provide working hands-on support, software and hardware demonstration set ups, shared manufacturing / teaching facilities and aid in technology transfer projects. These centres are established on merit based competition. Funding from the government is provided for the initial six years of their operation on a sun-set basis and on expenditures incurred each year i.e. 50% during the first year, 50% during the second year, 50% during the third year, 40% during the fourth year, 33% during the fifth year and 33% during the sixth year. A similar facility is a prime requirement for the country, he observed.

The presentations were followed by very lively discussions. Some of the points on which there were deliberations included bench marking of consultancy services, economizing of consultancy services, confidentiality of research collaborations with consultancy organisations, reliability of consultancy services, consultancy accreditation and thrust in consultancy services for exports.

While concluding the Session, the Chairperson, Shri A. Parthasarathi, made several suggestions. Some of these are:

In the present scenario, there is a great challenge for the consultancy system to meet the requirements of small and medium enterprises and enable them to enhance their capabilities in effectively competing in the domestic and global markets.

In India, either individual consultants or large companies are engaged in consultancy. There is a need for nurturing the growth of medium size consultancy organisations to cater to the increasing demands from industry. A scheme for accreditation of consultancy organisations may be thought of in future.

Role of consultancy in R&D leading to commercialization of R&D results is increasing. Consultancy adds value to the projects. There is a need to encourage greater participation of professional and talented consultants in technology development and commercialization of R&D results. With the increasing number of consultants and consultancy organisations, there appears to be a need for evolving codes of conduct for consultants and consultancy organisations. There should be benchmarks established through the ISO norms or other indicators.

Our consultancy exports must increase, apart from export of finished goods and services. Towards this, DSIR may evolve appropriate programmes.

DSIR may also disseminate information about government schemes relating to providing of technical assistance to other developing countries to accelerate the export of our technical consultancy services.

Session - III Technical Consultancy in Service Industry

Shri P.K. Rudra, Chairman, Consultancy Development Centre (CDC) chaired the session. Three presentations were made during the session.

Shri N. Parthasarathy, CMD, WAPCOS, New Delhi in his presentation on technical consultancy with special emphasis on water resources, brought out the need for consultants to identify the needs of the beneficiary and actively interact with the policy makers and beneficiaries to ensure that the programmes implemented based on the consultancy recommendations are optimally utilized by the beneficiary. Towards this the consultants would require to train the beneficiary. He gave the example of participatory irrigation management as an illustration. Shri Parthasarathy also brought out the need to improve the quality of the service provided by the consultants, to benchmark the consultancy process and document the developments in the process like innovative approaches so as to evolve consultancy from a desirable but non-critical activity to a desirable and critical activity fitting in the long term plans of the policy makers.

Shri B.I. Singhal, MD, RITES, New Delhi in his presentation focussed on the technical consultancy in the transport sector. In his vision of the future, this field would be experiencing a major boost with heavy investment by multinationals and that would bring

both opportunities and threats to the Indian consultants. The opportunity is the estimated market of Rs. 15,000 Crores for technical consultancy and the threat is the competition from the foreign consultants. He explained that to change the present picture of very small percentage of consultancy assignments bagged by the Indian consultants in the multilaterally funded projects, Indian consultants would be required to change their strategies and focus on build up of their competency, understand financial and bankability aspects of the projects, total life-cycle costs and avoid time and cost overruns by intensive planning.

Shri R.C. Kehar, Director-General, CDC, New Delhi in his presentation focussed on the building sector and has drawn attention to the technological changes that have made construction a multidisciplinary practice. To compete with the international consultants, Indian consultants would be required to focus on improved on-sight processes and procurement management of off-site prefabricated assemblies in factory environment with tight control on the cost and time. Shri Kehar also gave a brief overview of the activities of the Consultancy Development Centre and invited consultants to enroll their services with CDC, which is basically acting as a catalyzer to promote the growth of consultants.

The presentations were followed by lively discussions. Some of the points made were the need to take into account the demands on the availability of land to meet the large investment projects in infrastructure and the shifting of boundaries between consultants and contractors for large private sector projects.

In summarizing the proceedings of the session, the Chairman Shri Rudra emphasized on the need for bringing out accreditation system for consultants, regular upgrading of the consultants' capabilities, specializing in areas for consultants, focussing on the operation and maintenance aspects of the projects, asset maintenance. The Chairman expressed the hope that the Indian consultants would rise to the occasion, benchmark their capabilities with respect to the international consultants and win sizable share of the consultancy assignments in global markets.

Session-IV - Role of Technical Consultants in R&D

The session was chaired by Dr.S. Varadarajan, President, INSA. In his opening remarks he highlighted the importance given to the consultancy profession abroad and the exchange programmes existing in European countries like Holland, Germany, Switzerland where professors and students spend time in industry as part of their efforts for producing outstanding R&D results. Similarly scientists are also made to 'work in industry. In India, there is a lack of such flexibility and hence needs to be looked into for producing tangible results. In the present liberal environment, the obsolescence varies from 5 to 7 years in industries like Chemical and manufacturing and therefore, he emphasized for complete rethinking on structuring our systems and controls.

Shri T.S. Venkataraman, MD, Esvin Advanced Technologies Ltd., Madras presented a lucid role of consultants in R&D with greater emphasis on management of creativity. Through an illustration of his experience in developing a process for production of newsprint from bagasse, he brought out how an operating commercial organisation could interact with technical consultants in producing meaningful R&D results incorporating creativity in the process. Motivation of R&D organisations for commercializing innovative technologies and creativity management has been emphasized in his talk.

Shri S.W. Patwardhan, GM IDBI, Mumbai brought out the role of financial institutions in supporting R&D based technologies. He expressed the problems faced by financial institutions in identifying potential indigenous technologies for venture capital funding in view of the fast changing scenario of technologies in various industries from fisheries to air-craft manufacturing. In this connection he found a significant role of technical consultants in evaluation of technologies and helping the financial institutions in taking decisions on financial support to new and emerging technologies.

Shri N.K. Sharma, MD, NRDC, New Delhi, speaking on the changing role of consultants in their approach to services from market survey to project management, brought out the basic differences emerging in the new approach to consultancy services compared to conventional approach, hitherto

followed. The new approach comprises market survey projecting existing manufacturers in India and in the world, demand, product/process parameters, intellectual properties status, test marketing, technology evaluation, design of pilot/demonstration plants and preparation of 5 to 10 years technology plan for the industry. He also presented NRDC experience in the commercialization of the technology of Zeolite-A, developed by CSMCRI, Bhavnagar, applying the new approach.

Dr. R.S. Venkataraman, CMD, EIL, New Delhi, presented his experiences and the growth of EIL as a major consultancy organisation in the country over the years. He called for a paradigm shift in integrating R&D work with commercialization process, in view of the liberal atmosphere thrown open. There is a need for university collaboration with institutions in developing strong areas. He further said that skills available in India are not concentrated but distributed in various organisations, industry and R&D laboratories. He laid emphasis on concentration of skills, greater interaction between R&D and industry and promoting technology based engineering companies with hands-on experience.

Dr. A.N. Dravid, MD, Humphreys & Glasgow Consultants Ltd., Mumbai pointed out the need to define technical consultants and the types of roles a consultant is required to play. In the present activities the consultant has an advisory role and participatory role. His advisory role, in his opinion, is very essential for policy making bodies like 'Science and Technology Committee, industrial development; as a technical consultant has a real pulse of the market and the emerging technologies. He drew the attention of the policy makers to include technical consultants while framing policies and not do the same in isolation from technical consultants while setting goals. The consultant participatory role is essential for alerting and preventing the industry from entering into not cost effective technologies. He further emphasized that the efforts of consultants should get into closely guarded areas held by the foreign companies.

Summing up the deliberations in the session, the Chairman brought out a number of areas wherein there is a greater role for technical consultants. Some of the areas include engineering industry, leather and food processing industry, capital goods, house-hold consumer goods and engineering design. Other areas that need to be addressed while appreciating the R&D efforts in which the consultants are required to be involved are, water recycling, manufacturing industry, automation, production of a variety of consumer products, concern for high reliability, quality system development and promoting technology based exports.

Session-V : Policies for Promoting Technical Consultancy at Home and Abroad.

The Session was chaired by Prof. V.S. Raju, Director, IIT, Delhi. In his opening remarks, the Chairman observed that there is a greater need for strengthening interactions and linkages among academic institutions and consultants to promote technology development. He gave the rich experience of IIT, Madras and IIT, Delhi on how their consultancy services to the industry have grown over the years. He also stressed upon the importance of networking of R&D, consultancy organisations and users. He also said that there is a greater need today for leveraging technical consultancy for innovation. There should be right policies, strict controls and time targets. After the opening remarks by the Chairman, there were 5 presentations from eminent speakers.

Dr. Uddesh Kohli, CMD, Power Finance Corporation Ltd., New Delhi in his address emphasized that the infrastructure sector is a high investment sector and provides tremendous opportunities to technical consultants in project planning, technology selection and implementation. Technical consultants would be needed both by the clients as well as by the financial institutions. He suggested the following: organising tie up of Indian technical consultants with foreign consultants, and with R&D organisations within the country; networking of consultants with industry and associations; training and professional development of consultants; and proper packing and marketing of consultancy.

Shri S.P. Aggarwal, Joint Adviser, DSIR in his address gave an overview of the present status of the technical consultancy in India and also the international scenario and the various policy measures needed for promoting technical consultancy services in India. He highlighted the various measures and policy initiatives taken by DSIR in promoting technical consultancy in India. He projected in brief the Ninth Plan programme for promoting technical consultancy and enhancing linkages between industry

and R&D institutions, and the need for setting up of a Design Engineering Centre. He further stated that technical consultancy in India is lacking in food processing, environment, safety and renewable energy resources. In the services sector, the weaknesses are in technology development, innovation, design and engineering, particularly in small and medium sectors. No specific policies or incentives have been formulated for encouraging consultancy, except some incentives like MDA, and income tax benefit given by the Ministry of Commerce. Shri Aggarwal suggested the following: technical consultancy should be considered at par with R&D institution/ organisation and exporting units for availing various benefits/incentives and incentives for consultancy export; upgradation of technological capabilities of technical managers; enhancing interaction of industry with R&D institutions and other academic institutions; setting up of Design and Engineering Centre; registration and setting up of standards for services sector consultant and emphasis on ISO 9000 certification for consultants.

Shri N.F. Patel, President, Consulting Engineers Association of India in his address focussed on the theme of the Conference with specific reference to the policies for promoting technical consultancy at India and abroad. He mentioned that Indian technical consultants lacked exposure to the state - of - the - art technology, vis-a-vis the foreign consultants. He highlighted new areas of technical consultancy in energy conservation, operation and maintenance, management, software, pollution control, infrastructure and renewable energy resources. Consultants should adopt modern techniques and technologies and employ trained and skilled manpower for executing the jobs. Technical consultants in India today face the challenges of resources and exposure to modern techniques and technologies. Various suggestions included consortia approach for strengthening the capabilities of technical consultants; speedier adoption of new techniques and technologies; strengthening linkages with R&D organisations and institutions; and exploring opportunities abroad.

Shri Sanjeev Tamhane, Assistant Vice - President, ICICI, Mumbai in his address highlighted the ICICI programme of commercializing the technology from the lab stage to the final product and the possible routes for tapping international markets for technical consultancy, viz. sub contracting, joint ventures and direct selling of technology. Important issues to be addressed by the consultants are : commercial aspect of the technology (pricing, guarantee and market); institutional aspect of the technology (in terms of documentation of technology, organizing data base and industry institution linkages), financial aspects (in terms of government loans and grants); and legal aspects (in terms of guarding secrecy of the technology).

Shri S. Sridhar, Resident Representative, EXIM Bank of India, New Delhi in his address briefly covered the policies pursued by Exim Bank for exports and discussed about exports of technical consultancy services. He mentioned that the overall performance of the service sector including turnkey projects has been fairly good. He highlighted the activities of the organization particularly in respect of multilateral funding programme. He briefly explained the scheme of reimbursement of bidding by consultants which envisages full reimbursement to the consultants after the bid is approved. He mentioned about the MoU signed with IFC, Washington and other financial arrangements with financial institutions on deferred payment terms etc. He also mentioned about the large potential available for joint ventures in technical consultancy. He made the following suggestions: networking of Exim Bank with international firms; building data base; assistance to consultants in evolving marketing strategies.

The presentations were followed by lively discussions on the policies and promotional measures required for promoting technical consultancy. The Chairman in his concluding remarks made the following observations : payments to consultants generally is reported to be inadequate which should be looked into; there is need to regulate the appointments of consultants so that proper consultant is appointed for the proper job; need for proper planning of projects and procedural audits of projects should be introduced instead of performance audit; incentives to be given to consultants for timely completion of the projects and penalties to be imposed for delayed completion of projects; the productivity of the consultants should increase and emphasis should be laid to attain international standards; there is an urgent need for networking between academic institutions, consultants and end users.

Valedictory Session

Dr.M.R. Srinivasan, Member (Science), Planning Commission was the Chief Guest at the Valedictory Session. He released the DSIR special publication "Compendium on in-house R&D Centres - 1996" and also delivered the Valedictory address. The Session was presided by Dr. R.A. Mashelkar, Secretary, DSIR and DG, CSIR. Dr. V.V. Subba Rao, Adviser, DSIR presented the highlights of the various sessions. Dr. Amit Mitra, Secretary General, FICCI presented the suggestions and recommendations arising out of the Conference.

Dr. Srinivasan in his Valedictory address congratulated the DSIR National Award winners for their outstanding R&D achievements. He emphasized the need to have scientists and technologists on the boards of major companies, as R&D in industry was an issue which should be seen in global terms and without proper scientific and technical know-how R&D would be in doldrums. Though an awareness and some introspection had been done in this regard, much more needs to be achieved in this area, he said.

Dr.Srinivasan stated that while on the technology front, a strong base had been built up, on the management side several weaknesses had developed particularly in procurement, value of money and time control. It was a matter of concern and a justified concern on the part of all international lending agencies on the very poor utilization of funds by India. This reflected a certain degree of failure in India's overall management system and running of mega projects. A singular weakness had been that India had not been able to come in terms with the finance and project management.

Dr. Srinivasan stated that the non-utilization of investments in industry was an area of concern; proper utilization could be achieved by having competent consultants. The absence of competition has also been responsible for a seller's market and thereby giving no push for new innovations and projects. Quoting an example, he said that the Chinese have invented a battery operated scooter and yet till today the Indian industry has not been able to produce a similar battery operated vehicle. It has not been able to innovate in spite of the capacity to manufacture a large number of scooters. He also said that industry in India wanted to maximize profits on the basis of tax management and duty management. It has now to turn towards R&D as the general run of the industry did not have any line inputs of people with knowledge in science and technology. This was very essential as otherwise the strengthening of linkages would become a pious hope.

Many Indians seem to think that R&D means quantum jump. What is needed is the incremental improvement and this is where the Indian ethos come in as they did not know how to interlink their skills to commercial purposes. Absence of innovativeness in shop floor level and taking too little interest in providing access to knowledge, have been the reasons for the failure in R&D front, observed Dr. Srinivasan.

Dr. Amit Mitra, Secretary-General, FICCI presented a warm vote of thanks.

Suggestions and Recommendations

1. In the liberalized environment, foreign collaboration agreements have increased substantially. Foreign investment approvals also have increased several-folds. Domestic R&D system and industry are confronted with the challenge to compete both in domestic and global markets. In the post-liberalisation period, there is a greater need for our industry to enhance investments in R&D and take up globally competitive technology development.

2. Fiscal incentives and support measures to encourage investments in R&D by industry are essential. The package on fiscal incentives available, including those announced in the Union Budget 1996-97, provide an attractive proposition for the industry to increase investments in R&D. Industry should take full advantage of the incentives made available by the Government and establish closer links with CSIR and other national R&D systems, universities and IITs in their pursuit of raising the technological levels in industry.

3. Industry should undertake innovative, large and multidisciplinary development programmes to establish leadership in a few selected areas where we have comparative strengths at global levels. Towards this objective, industry may take full advantage of the government funding schemes, such as, Technology Development Fund of DST, PATSER of DSIR and other similar schemes including venture capital.

4. With the presentation of 1996 DSIR National Awards for R&D, 88 companies have bagged the prestigious award for excellence in R&D. By the next R&D Conference in 1997, the scheme would be completing a decade of its implementation. DSIR may bring out a status report covering the performance of the award winning technologies and companies over the years, especially with a view to assess the continuous technology upgradation, economic benefits, survival in the competitive environment, etc.

5. There is an increasing need to encourage and enhance the export of large value added products and services as well as projects and technologies. Towards achieving this objective, DSIR may reinstate the National Award for R&D leading to Export of technologies.

6. Technical and Engineering consultancy play an important role from conceptualizing an R&D project to the commercialization of R&D results. Many of our consultancy organizations have not only rendered technically competitive and cost effective services for domestic projects but also have penetrated into several other developing countries. Notwithstanding these, there are several areas of technical consultancy which need to be encouraged, mainly in areas such as (a) pollution control and environment protection, (b) energy management, (c) new energy sources, (d) quality standards, (e) design and engineering services, and in particular, in areas having greater export potential and also those having direct relevance to small and medium enterprises.

7. With our ambitious national development plans and priorities, there is an urgent need to promote and set up design and engineering companies in specific sectors, such as, food processing, non-conventional energy and environment. Technical consultancy organizations should also obtain certification under ISO series of certification.

8. Consultancy profession has grown considerably in the country. It should be the endeavour to see that only right type of consultancy organizations and consultants are promoted. This can be achieved through evolving a registration scheme for consultants based on certain laid down criteria and guidelines. DSIR may further examine the desirability of such a scheme for implementation and take further steps in this direction.

9. Consultancy organizations should strictly follow the code of conduct and professional ethics as has been laid down by the International Federation of Consulting Engineers or by other promotional organizations.

10. Investments in infrastructure in India are proposed to be raised substantially, including in areas such as power, oil, telecommunications, transport, etc. Development and implementation of infrastructural projects involve production of several equipment, products, materials and services, including consultancy services. There is a pressing need to build a core of highly skilled, talented and experienced consultancy organizations, apart from strengthening the existing consultants and consultancy organizations. DSIR and FICCI may take appropriate steps towards achieving the objective.

11. In the changed industrial and economic scenario, it is necessary for our consultants to continue to strengthen and upgrade their technological and managerial skills and capabilities to undertake major projects in India and abroad. DSIR and FICCI may evolve schemes to support such initiatives.

12. Consultancy export should become the main focus of attention in the coming years. We should aim to reach technical consultancy exports to the level of at least Rs. 5000 crores by the turn of the century from the present Rs. 1200 crores. The domestic consultancy organizations should be given export incentives at par with those available in other sectors. DSIR and FICCI also may evolve schemes to provide necessary support for achieving this target.

13. Consultancy companies should establish "Brand Names" for India in the area of consultancy services.

14. Our universities and technical institutions should increase their interactions with industry and the academics should get involved, at least as part of their work, in solving short-term and long-term problems in industry as well.

15. Close linkages and interactions among consultants, national R&D system, university system, financial institutions and industry need to be encouraged to make technical consultancy in India a real lever for innovation in the years ahead.

16. In the Golden Jubilee Year of India's Independence, i.e., 1997, DSIR and FICCI should organize a major National Conference on "R&D in Industry : Retrospect and Prospect".

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BOOK REVIEWS

Indicators of Indian Science and Technology, by Ashok Jain, S Pruthi, K C Garg and S A Nabi (Segment Publishers, New Delhi 110 048) 1996, pp 151, Price: Rs 695/=

It is difficult to comment upon this book as it is full of primary data on various indicators of Science and Technology (S&T). It is not reviewer's intention to discuss each of the eleven chapters included in this volume. Nevertheless, chapter seven and eight on 'Technology Transfer and Perception of Scientists' are vital. These two chapters are directly related to chapters one to six, and also to nine to eleven.

The overall objective of the authors to collect data on as many indicators as possible is not clear. However, it is obvious that these would provide necessary inputs for researchers in the field of S&T policy, management of science, science journalism and issues related to planning in Indian S&T.

Probably for the first time one comes across an estimate of survey on several aspects affecting R&D activities in Indian research labs. Although perception and interpretations might vary from expert to expert but ultimately the feelings and opinion of working scientists are everlasting. As this class is responsible for delivering the results, one cannot and should not ignore their perceptions while making an assessment of scientific progress and impact that it has made on Indian economy.

By analysing actual investment data on human resource development, education and research, one can find the reasons as to why India is now a leading exporter of surplus technical manpower and computer based technology. Once we duly reckon with apparent and not so apparent data on patents, technology transfer and joint ventures, it is not difficult to face a harsh reality that there is room for making S&T more relevant to need of our society and economy.

Ironically, medium and large sectors are more interested to import technology while the small sectors interested in indigenous know-how are not receiving due attention from various Indian R&D labs (excluding agriculture sector). Most of the scientists are busy with big and expensive projects and they do not find efforts rewarding if they work for small sector problems. It has been established now that small sector in our environment can provide more employment and boost economic growth.

Improving technology management and technology transfer is meeting tenacious problems. Not because technology is half cooked or entrepreneurs are half baked but also because there is no formal or informal mechanism to associate potential buyers of technology during development stage to ensure risk-free success. Joint sectors abroad with Indian and overseas partners are successful because technology and market is well established. R&D labs do not have resources or methods to obtain reliable market survey reports on the product or process developed. There is need to cultivate a group of scientists who are part of a project team but works to provide feed back on various aspects of market and technology status to obtain updating wherever necessary.

The real value of this book can be realized if the data are analysed and studied in order to make R&D efforts more striking in India and abroad. Smaller projects are to be taken up so that scientists get job satisfaction and results obtained are easily translated into technology development suitable for production. People realistically expect that R&D labs would come to rescue drainage of foreign exchange by adoption of liberal policies in working an administration of technology development. The book at this price is somewhat expensive and generates need of a second Volume as more data on S&T are required on post-liberal policy period.

S K SHARMA
E 34F, MIG Flats, Mayapuri, New Delhi 110 064, India

Education, Training and the Global Economy, by David Ashton and Francis Green (Edward Elgar Publishing Ltd, Glos GL50)1996, pp 227+(xiii), Price: £49.95
[ISBN 185278 970 0]

The central theme of the book under review is: "salience of nations' education and training system in the struggle for competitive superiority". In the initial chapters, the book attempts to show the number of ways in which writers of various academic disciplines and political commentators have examined some of the conceptual issues involved in identifying the link between education and training systems, and the economic system of a country. Starting with the "Human Capital Theory"—a theory that looks at education and training as a form of investment having a future material pay off, the book goes on to discuss the "Internal Labour Market (ILM) Approach", which premises the effectiveness of training on the nature and existence of an internal labour market. The third approach discussed is the "corporatist approach"—a system where occupational labour markets are supported either separately or along with the internal labour market.

With a view to analysing the education and training systems against the background of, and on the basis of major developments in the global economy, the book considers the changing demands for skills that education and training are designed to meet. While considering how societies arrive at a particular level of skill formation, the following six requirements are identified:

(i) An innovative production system;

(ii) High levels of basic competence in language, science, mathematics, and informative technology among school and college going learners;

(iii) Commitment of employers to the goals of high level skill formation;

(iv) Regulation and accountability in the process of skill formation at the work place;

(v)Consent by the workers and the prospective workers to the process of skill formation; and

(vi) On the job learning to complement off the job training.

After discussing the theoretical "bones", the authors proceed on to put some "empirical flesh" to show, why is it that some societies arrive at a situation whereby education and the training systems produce a relatively low level of skill formation. Through a discussion of the history of the U K and the USA, the authors argue that, lack of commitment by employers to high skill formation is by no means universal in the modern day. The larger enterprises in the leading industries establish an institutionalized system of workplace-learning which enables them to continue to compete at the leading edge of the world markets. However, most employers prefer to choose the "low skill" route, since it is profitable to rely on "cheap malleable labour". The authors then go on to distinguish within the "high skill" routes—the routes followed by the second wave industrial nations viz. Japan and Germany, and those followed by the "Newly Industrialized Economics" (NIEs) of the pacific rim viz. Hong Kong, Singapore, Taiwan, and South Korea.

Since the education and training systems that developed in these latter countries were more closely geared to the demands of the productive system, these were characterized by lower autonomy than those of the first wave nations. Because of the delay on the part of the NIEs bid to enter world markets, the autonomy of their education and training systems was, in fact, lowest of all. Thus, in education, Japan, Taiwan, and South Korea have involved a common model distinct from that of the prevailing in the West. This, according to the authors, is the key aspect of the Asian economic success. Ultimately, in the concluding chapter, the book attempts to answer the critical question regarding, what can be learnt about the general framework of education and training policy making at the turn of the millennium.

The book is a well-written publication on an interesting topic. It also has an extensive bibliography running to thirty-three pages, which can be of immense value to the scholars concerned with these issues. It will be an useful addition to the libraries and to the collection of those individuals who are working in the fields of policy-planning in education and training and in labour economics.

The book should also be of interest to a lay man who thinks.

M CHANDRA
Department of Education in Science & Mathematics,
National Council of Educational Research and Training,
New Delhi 110 016, India

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SCI-TECH UPDATE

MS announces new OS for hand-held devices

Microsoft Corporation have announced their new OS for handheld devices such as personal digital assistants, cellular smart Phones, digital pagers, Internet appliances, Internet World Wide Web (WWW) phones, and next generation entertainment and information devices.

The new OS, Windows CE (code name Pegasus) is designed for a wide range of low power consuming devices with a focus on communication and WWW access. The first products to be used with the new OS are a new category called Handheld Personal Computers (HPC's) which will be shipped by the end of 1996.

Windows CE, according to Bill Gates, CEO,Ms Corp., extends our vision of Information at one's finger tips beyond the PC, for customers whether they are at home, in office, in school, or on the road.

Windows CE is getting support in terms of microprocessors, devices, and software applications. Hitachi Ltd has announced its SH-3, a RISC microprocessor as a key power source for Windows CE- based devices. The new OS is a 32-bit OS with multi tasking, multi threading and "Open architecture", supporting different microprocessors. Internet access is also possible through a built-in customized version of Microsoft's web-browser [*Comput Today*, 12 (140) (1996) 37]. ❑

DSRM

Statistics software adds graphical equation modelling

SmallWaters Corp.. Chicago, have produced amos 3.5 for Windows which is a structural equation modelling program, featuring an easy-to-use graphical interface.

Amos eliminates the need to write one's own equations or specify models in a programming language. Amos' capability for causal modelling enables one to go beyond conventional factor analysis and multiple regression. One can find answers to design equations, and present them in path diagrams. SPSS Inc. of Chicago is a distributor of Amos, which one can access through menus on SPSS statistical software.

Meanwhile, SPSS has come out with a CD-ROM containing an array of tools and data, including the base module for SPSS 7.0 for Windows and census information from Wesses, Inc., and Claritas, Inc. [*Des News*, **51**(13) (1996) p.16]. ❑

HKK

Multidisplay computer screens

In the field of personal computers, constant efforts are on in achieving better and better storage devices, faster and faster memories, smart printers, etc. The increasing demands of multimedia overload of data to be displayed on a computer screen is also rising. In an exciting innovation to cope up with the outpouring of information, the Japanese electronics giant, Hitachi's researchers hit upon the idea of adding an additional screen if one screen is found wanting.

The Hitachi team says that multidisplay systems are necessary and should be exploited in a multimedia environment. At the same time, the proposed solution aims at a design of a friendlier foldable flat screen display resembling a folded book as a peripheral instead of getting spread here and there on the desk.

The prototype built is based on connecting two or more active matrix LCDs mechanically and electrically. It can be opened up and laid on a table. The researchers feel that the system could be useful whenever information needs to be manipulated and data, tools and a work space are all needed. An interesting application suggested of the system is as an electronic translator. In such a situation, two people sit with the display between them, looking at equivalent text, inverted towards them, in their respective languages. One person points to a phrase by touching the screen causes the equivalent phrase to be displayed on the other screen. It is also pointed out

that two 250 mm active-matrix LCDs are much cheaper with the same area, about 355 mm diagonally [*Electron Wrld*,**102** (1996) 452]. ❑

DSRM

First network computer launched by IBM

Efforts were on from last year to market a network computer by many leading vendors that will derive all its software from network without having to spend for it, mostly keeping in view the requirements of students.

IBM has now launched the first network computer aimed at corporate users, called IBM Network Station, priced around $ 700 not including the monitor. This series also called "thin clients" are systems with local processing power and memory, but no storage, designed to download their applications from network servers.

The Network Station has a Power PC microprocessor and 8 MB of memory expandable to 64 MB. It is versatile in that it can hook up to a corporate Ethernet or Token Ring local area network and provide access to the Internet and/or the corporate intranet can concurrently access java, Windows NT, UNIX, OS/2, IBM As/400, and system/390 servers as well as Internet applications. It comes with the browser software, Navigator 3.0, from Netscape communications Corp , customized for the IBM device. It measures by 10"x1.25" and weighs two-and-half pounds. (Monitor's cost is extra). The Monitor needs to be VGA compatible. An optional external diskette drive can be attached through a PC card slot. IBM feels that the Workstation may serve as a replacement to the 10 to 15 million PC connected to the IBM servers alone [*Comp. Today*, 12 (40) (1996) 32] ❑

DSRM

Environmentaly friendly building

With various efforts being directed towards saving environment - in designing pollution-free automobiles, refrigerators free from CFC, recycling paper, manufacturing greener computers, finding possibility of greener and energy production technologies- any attempt is welcome, and it is in the fitness of things that the Environmental Sciences Building at Weizmann Institute is designed in an environmentally friendly way. It contains a range of special features that promise to cut electricity expenditure for lighting, heating and cooling nearly in half.

The spacious roof that would otherwise allow heat to escape in the winter holds a hothouse for plant research, which not only keeps the heat in but actually serves as a source of warm air pumped into the heating system. In addition, the large roof surface contains numerous skylights that provide natural lighting.

Light also pours into the building's labs and offices through large windows equipped with special sun shades and Venetian blinds that act as light shelves, to direct the light into different parts of the room while outside grids cast a shade that prevents overheating. The need for airconditioning and heating is further reduced by thermal insulation in the walls and ceiling fans that create a cooling breeze in the summer and prevent hot air from accumulating at the ceiling in the winter. During summer nights, a special system will let cool air from the outside into the building thus reducing the need for daytime cooling.

Further, the building is equipped with smart sensors, valves that optimize the use of power in fume hoods and airconditioners. Electric lights are fitted with special reflectors that diffuse light throughout the room and switches that are automatically switched off when not in use.

The building houses about 80 members of the Institute of Environmental Sciences and Energy Research Department [*Weizmann Institute of Science News*, November 15, 1996]. ❑

DSRM

Radio that works on winding

Radio is a powerful medium by which useful information can be communicated to wider masses including distant education. Trevor Baylis has won the prestigious BBC Design Award for 1996 for inventing what is called as Freeplay radio, a clockwork toy with a serious dimension. He was moved by television reports about the spread of AIDS in Africa and the vital health information in this regard could not be easily spread to the remote areas taking advantage of the radio broadcasts because majority of the people had no access to electricity or could not afford the cost of batteries.

It is in this context the invention of Baylis is counted as aesthetically pleasing. The radio requires

no batteries and relies on a clockwork mechanism as a power source and withstands most climatic conditions. It gives 30-40 min of clear listening time after only 20 s of winding. Baylis got the idea on the way that old fashioned wind-up gramophones worked. The main principle on which the radio works is the same as that of an alarm clock. When it is wound for about 20 s, electricity is generated and the radio stores and distributes the power constantly over a period of time.

Financial support for the project was given by the Overseas Development Administration (ODA) and approval for the same was given by president of South Africa (SA). Jobs are being created in SA where an organization for the disabled is manufacturing the product using production lines specially designed for the handicapped workers —) some visually impaired and others who are users of wheel chairs.

In Eritrea, the ODA is supplying the new radios to the Ministry of Education as part of an innovative mass education project. Many are being acquired by relief agencies, such as the International Red Cross and UNICEF. These will play a vital role in providing distance learning and in a new adult education radio channel. The British distributors, Baygen Power will donate some sets for distance learning and health information projects in Afghanistan and Africa. The radio is priced around 80 pounds and is available from the IT Bookshop, 103-105 Southampton Row, London. Further information can be had from; Baygen Power Manufacturing, 13 King Henry Tower, Sovereign Close, London [*Brit Comm News*, November/December 1996, p.21; *Appropr Technol*, 23(2) (1996) 13]. ❑

DSRM

Corrosion protection of concrete bridges with silane

Concrete bridges on highways are required to be protected from the corrosion caused by de-icing salts. The chloride ions in rock salt cause reinforcement to corrode and generate expansive forces which cause cracking and spilling of the concrete.

One method used for protection is to apply a hydrophobic impregnant known as silane to the concrete surface and Highways Agencies adopt this method. Silane is a colourless liquid which is sprayed onto the concrete surface and forms a hydrophobic pore lining. The trials conducted by the Transport Research Laboratory (TRL), UK have shown that the ingress of chloride ions into a treated abutment on the M25 after 8 years was reduced by 42%. The standard, at present, specifies the use of a monomeric isobutyl trialkoxy silane. TRL was commissioned to develop a series of tests to form the basis of a performance specification to be included in the standard.

The tests measure the water vapour transmission, resistance to chloride and durability of the material when applied to concrete. A 'round robin' type of tests on products currently available will be conducted independently by eight laboratories using the same test methods.

Tests conducted by TRL at different sites are aimed of quality control studies to chemically characterize the products actually being used, to assess their long term performance and to determine which areas of a structure have been treated [*Res Focus*. Inst Civil Engrs, UK, No. 27, 1996, p.4]. ❑

DSRM

Mobile machine for simple recycling

Peter Mucci at the University of Southampton, UK, has developed a mobile machine which will provide a cheaper sorting solution, thereby making plastic recycling more viable. The machine is called 'Portasort'. By its help, plastics for use in automotive recycling plants will be identified.

The machine is available from Intex Logistics of Petersfield, which offers two services, including a mobile 'man with a van' service taking the machine to plastic recyclers and manufacturers. Portasort can be hired on a short term basis and requires no specialist knowledge from its operator. Alternatively, postal identification is possible from the company's headquarters.

Using a reflection IR scanning technique, samples ranging from bottle tops to car bumpers can be identified in just a few seconds. Coatings of paint or other finishes can be identified in just a few seconds. Coatings of paint or other finishes can be pared away from the sample tool prior to scanning for revealing the plastic surface.

Portasort uses a Nicolet spectrometer as its IR source and couples its own software with a database that contains over 2000 commonly-used plastics. The aim is to update the database continually with manufacturers' details and prices, giving an up-to-the

minute readout on scanning, including details of recommended purchasers for the sampled material.

It is believed that the Portasort is the only accurate method and is simpler to use and convenient to transport.

Many potential applications are in the pipeline; banks and police services could use Portasort to provide an additional means of identification for banknotes and credit cards in the fight against forgery. Retrieving the plastic casing for computers is another major application, as is bench-marking, i.e. checking the composition of a product, to ensure that the stipulated piller and copolymer requirements have been met. Defence applications have also been attended to, although the details are not being disclosed.

In addition to the Portasort, a pen is being developed which uses electrostatic measurements to distinguish between any two pre- programmed plastics. It is called the 'Triboben' and the method will rely on a triboelectric charge on the plastic surface being matched with a reference charge held on a preprogrammed chip. Several world patents are held for both devices.

Despite the encouragement of stricter disposal regulations for plastics, recycling has not yet taken off. As identification becomes easier and less costly, the Portasort and other machines like it may come into their own, and help to reduce burgeoning landfill requirements [*Chem Br*, 32 (10) (1996) p. 18]. ❑

HKK

Combustion of solid carbon carriers

In the field of processing of industrial residues for reclamation of reusable contents especially by thermal treatment methods, interest is now concentrated in the generation of hot process gases on the basis of various solid carbon carriers.

In the rotational firing employed by Loesche GmbH, the solid material is pneumatically and tangentially fed into the cylindrical combustion chambers via a number of nozzles distributed over the length of the combustion chamber.

An oil or gas fired start burner is used to heat the internal surfaces of the combustion chamber to a temperature sufficient to ignite the granular carbon material. This is shut off after the start of ignition. Measurements of the degree of burn-up at the exit of the combustion chamber is greater than 99.99% with CO values of around 40 ppm/m^3 (STP). The thermal capacity of these burner system is between $17X10^6$ kJ/h and $25X10^6$ kJ/h. It is also possible to efficiently carry out combustion of materials containing carbon without volatile components.

This process is particularly useful in view of the more stringent environmental laws which offers a way to thermally dispose off pollutant containing sold materials and recover reusable materials. Keeping the basic arrangement of the plant the same, detailed modifications are to be effected according to the type of the material to be combusted [*MPT Intl*, 19 (1) (1996) 83]. ❑

DSRM

New technology to help raise sugar production

The Cane Separation System (CSS) developed by the Sugar Technology Mission (STM) of the Department of Science and Technology (DST) would increase the sugar production by 30%. The DST helped install the first plant with the new technology, commissioned at Kothari Sugars and Chemicals Ltd at Trichi, Tamil Nadu.

The STM provided the technical know-how and initial finance to initiate the new process which virtually increases the sugar production by about 30% over the conventional process of extracting sugarcane juice from sugarcane through three roller mills. Besides, the sugar industry could increase its earning by selling the high quality 'rind' used in the paper industry. The process would revolutionize the sugar industry. The DST improved upon the CSS developed by the US giant Amcane International, Inc. in Jamaica and made it fit for commercial use. It was installed at a capacity of 400 tonne cane/d and the juice extracted from the sugarcane through this process is primarily sold for drinking purposes in 'tetrapak' pouches.

So far there has not been any replication of this new system because the cane industry has been sceptical on its commercial applications, primarily due to the anticipated limitations on its size. The SMT undertook the evaluation of the CSS and felt that it should be feasible to commercially exploit the technique at a capacity of 1200 tonne cane/d or more.

Apart from the higher production the advantages of the CSS include: higher efficiency of juice extraction, better juice quality, lower loss of sugar in bagasse, filter cake and molasses, thus yielding higher

sugar recovery, less use of chemicals for the purpose of juice purification and low energy consumption and superior sugar quality. The sugar industry could also benefit by selling the 'rind' separated from the cane stalk, which could fetch very high price as compared to conventional bagasse, as rind with long fibre would be an excellent raw material for paper industry [*Chem Ind News*, **41** (No. 3) (1996) p. 1209]. ❑

HKK

Pilot-scale PDO from sugar route

A biological process for production of 1,3-propanediol (PDO) is being developed by DuPont in collaboration with the industrial enzyme company Genencor, a joint venture between Eastman Chemical and Cultor. The single-step fermentation process uses corn sugar as feedstock. DuPont is planning to begin pilot scale operations soon.

Laboratory-scale studies have produced the polymer intermediate at an 'excellent yield" said Bruce Whitehouse, director of technology and new business development for DuPont Nylon. A number of micro-organisms were previously known which converted glycerol to PDO with poor yields. Using recombinant DNA technology DuPont has been able to engineer a number of bacteria and yeasts which could produce PDO from sugar substrates.

DuPont has a wide range of patents related to the technology and about two years ago decided to begin a collaboration with Genencor to speed development. Rather than go it along DuPont decided to take advantage of Genencor's considerable technical capability.

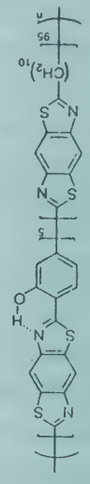
DuPont is committed to developing polymers based on renewable feedstocks. If the process is commercialized it will be the first commodity chemical to be produced using recombinant micro- organisms and DuPont believes this is well within reach.

The PDO produced by this process could be used as a feedstock for polytrimethylene terephthalate (PTT), a polymer with the same properties as PET which could be made in existing polyester fibre plants. Shell is commercializing PTT as Corterra in the US, and uses an ethylene oxide-carbon monoxide route to PDO[*Eur Chem News*,**66**(1744)(1996)39]❑

Polymer lights up with voltage

Samson A Jenekhe *et al.* at the University of Rochester, New York, have developed a new polymer that displays a hitherto unreported property of electrically generated luminescence which may lay the foundations for new organic electronic devices.

The polymer, a hydroxylated poly-(benzodithiazole phenylene) derivative, not only luminesces when a voltage is applied to but also displays stimulated emission [*J Am Chem Soc*, **118** (1996)p.9438]. In principle, it will be possible to create a diode laser from these types of polymers.



Many materials have been developed earlier that luminesce through an excited-state intramolecular proton transfer (ESIPT) mechanism when stimulated by light. But now, the new polymer appears to be able to carry out this type of light-producing proton-transfer reaction with electricity. This phenomenon has been dubbed as electrically generated intramolecular proton transfer (EGYPT).

The discovery could result in the generation of the first organic material to be used in a electrically pumped laser. To create the reaction, the group started with end form of the polymer.With voltage, the polymer tautomerized to the excited keto form, which finally decayed, giving rise to electro- luminescence [*Chem Eng News*,**74**(41)(1996)p.30]. ❑

HKK

Ethane-to-VCM

Pioneering a new process which allows the use of low purity ethane to produce VCM, EVC is contemplating a potentially dramatic turnaround in its fortunes. EVC is expected to bring its demonstration plant for its single-stage ethane to VCM process onstream in 1997.

The company is building a 1000 tonne/year pilot plant at Wilhelmshaven, The Netherlands, and has

decided to develop the technology without seeking any partnerships.

Two years' operation would be required to prove the process, although its commercial importance could become known during the course of 1998, says a new report from analysts at Deutsche Morgan Grenfell (DMG).

The new process operates at a temperature of around 450- 470°C and uses low purity, technical grade ethane and chlorine or hydrogen chloride.

The process also requires oxygen or oxygen-enriched air and uses fluidised bed catalysts. The development of the catalyst allows the reaction to proceed at this lower temperature; temperatures over 500°C were previously required. EVC currently has four patents at the application stage worldwide, covering the process, catalyst and byproduct recycling.

The process uses feedstocks of chlorine, oxygen and ethane with high efficiency and minimal production of byproducts. EVC claims that the process can achieve over 90 per cent conversion to VCM.

The DMG report describes the technological breakthrough as 'dramatic' and says successful commercial development could transform the fortunes of EVC. DMG has calculated that the capital cost of a new ethane-to-VCM plant could be 15-30 per cent cheaper than existing technology.

The new process will take VCM production outside conventional petrochemical economics since the ethane price is driven primarily by its energy value (in comparison to oil), rather than petrochemical demand.

With commercial implementation of the ethane to VCM technology, the initial viability of VCM production in locations now unjustified will increase.

The economic advantages of the process may be great enough to compensate for locations now considered too high-cost for a PVC/chlor-alkali complex.

EVC has said previously that it would construct the first commercial-scale plant in an ethane-rich area such as the US Gulf Coast or the Middle East. However, it may be possible to build the plant in Europe due to North Sea ethane availability [*Eur Chem News*, **66** (1740)(1996)23]. ❑

Sewage to power without Smell

Environmental Solutions International a company based in Perth, is contemplating for the A$19 million (£ 10 million) oil-from- sludge plant. It is due to be built at a treatment works in the suburb of Subiaco by the end of this year.

Presently the water authority treats some sludge in open digester tanks, which can generate unpleasant smells. The new facility will be based on ESI's Enersludge process, which takes place in sealed units. It will be the world's first commercial Enersludge plant.

Enersludge converts carbonaceous material such as sewage sludge into petroleum-type products. The conversion takes place in two anaerobic reactors.

The first chamber is a large oven, in which dried sludge — between 90 and 95 per cent total solids— is heated to 450 °C. This drives off up to half the weight of the sludge as vapour.

In the second chamber, trace metals in the sludge act as catalysts. They convert organic compounds in the vapour and char, such as proteins and lipids, into hydrocarbons.

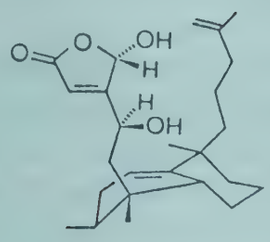
Besides the diesel-type oil, the process produces char, non- condensable gases and water contaminated with acetic acid. These can be used to generate hot gas to heat the sludge drier and the Enersludge reactors. The oil can be burnt in a diesel engine to provide on site power.

Roger Nicholls, one of Western Australia's water ministers, said the government could save about A$700 000 every year by generating electricity at the site. Densi Glennon, managing director of ESI, insists: "The issue is the processing of sludge, and doing that in a way that will be essentially odourless" [*New Sci*, **150** (2039)(1996) 23]. ❑

New terpene blocks protein phosphatase

Researchers at the Cornell University, Ithaca, USA, have isolated a novel protein phosphatase inhibitor from the Caribbean sponge *Dysidea etheria* de Laubenfels. The compound has been named dysidiolide, and its structure has been determined by single- crystal X-ray diffraction [*J Am Chem Soc*, **118** (1996) p. 8759].

Dysidiolide blocks the activity of a protein phosphatase called cdc 25A. This enzyme catalyzes the removal of phosphate groups from a protein complex



that signals cells to undergo mitotic division. Inhibitors of the enzyme arrest the cell cycle and are potentially useful in the treatment of cancer. The new compound is a sesterpene (with 25 carbons in the skeleton), and the organization of its carbon skeleton is the first to be reported for this small group of relatively rare natural products [*Chem Eng News*, **74** (38) (1996) p. 28]. ❑

HKK

Techniques accurately measure OH levels

Hans-Peter Dorn *et al.* at the Institute for Atmospheric Chemistry, Research Center K F A, Jülich, Germany, have made accurate measurements of the fleeting scavenger species with two instruments that are much more compact.

Dorn and his colleagues have performed the first successful inter-comparison of two local *in situ* techniques. It was exciting to observe the extremely good and absolute correspondence of both measurements, even under conditions where the OH concentration was changing fast during the day. They made their measurements in rural northeast Germany in August 1994 [*Geophys Res Lett*, **23** (1996) p. 2537; p. 2541; p.2545].

George H Mount at the National Oceanic & Administration's aeronomy lab in Boulder, Colo., has also measured OH radical using long-path laser absorption spectroscopy, a reliable technique that shines a tunable laser through the atmosphere to a mirror, collecting it back after the beam has traversed about 20 km. The long-path method used by the German researchers (also called differential optical absorption spectroscopy, works on the same principle but bounces the laser beam back and forth between two sets of mirrors set only 38.5 m apart, thus making the measurement local.

Dorn *et al.* in their field experiments have also used a method called laser induced fluorescence spectroscopy (LIF), an instrument that requires calibration but is small enough to fit into ships or aircraft.

The measurements agree remarkably well. It shows that routine measuring of OH is becoming possible.

William H Brune's (Pennsylvania State University, USA) own LIF instrument flew on a National Aeronautics & Space Administration plane in the spring 1996 and they got huge OH data. They are presently calibrating the instrument and analyzing these data [*Chem Eng News*, **74** (37) (1996) p. 9]. ❑

HKK

Preventing tragic side-effects of drugs

Researchers at the Department of Chemistry, University of Liverpool, UK, supported by the UK chemical and pharmaceutical industries are developing a catalyst which may be used in drug manufacture for preventing medical disasters caused by drugs such as Thalidomide damage reoccurring. This could be avoided if there had been a better understanding of the behaviour of drugs that are 'chiral' and therefore have two forms — a left-handed form and a right-handed form — such as Thalidomide. When used to prevent morning sickening in pregnant women, it can also cause limb deformities in their unborn children. The drug's chirality -- the fact that its molecules can exist in both left -and right- handed forms — was to blame; one form only was responsible for the tragic side effect.

Legislation is likely to be implemented in the UK that will require all chiral drugs to be administered as a pure, single, active enantiomer — the right-handed or left - handed form of the drug — the one that achieves the desired effect.

These can be obtained either by separating mixtures of right - and left-handed forms or by selective synthesis, offering a way to manufacture drug molecules comprising only the pure, active enantiomer from the outset.

This can be achieved either by starting with a naturally available reactant or by creating a new chiral centre from non- chiral reactants by using a chiral reaction environment. Chiral catalysts are a particularly efficient way of achieving the required chiral environment.

The Liverpool researchers' work is supported by the UK chemical and pharmaceutical industries which recognise catalysis as one of the key techno-

logical areas that the industry needs to harness in order to take advantage of emerging market opportunities [*Spectrum, Br Sci News*, **No.254**(1996)p.18].

❑

HKK

New journal launched by AFC

Agrivet Farm Care (AFC), the veterinary division of Glaxo India Ltd, a fore-runner in providing quality products and services to the veterinary profession in India has launched *VET-LINK*, a quaternary journal in October 1996.

The first issue covered the topic "Principles of Broad Spectrum Anthelmintics and Their Applications".

VET-LINK covers topics of field importance together with the latest developments in veterinary science. It links veterinarians with up-to-date information. ❑

HKK

Honours and Awards

Prof. C N R Rao awarded Einstein Gold Medal

Prof. C N R .Rao, President of the Jawaharlal Nehru Centre for Advanced Scientific Research, has been awarded the Einstein Gold Medal by UNESCO in recognition of his outstanding contribution to science. The medal was first minted in 1979 to mark the 100th anniversary of Einstein's birth.

The Einstein Gold Medal is one of the prestigious medals minted by UNESCO to mark the anniversary of Albert Einstein. It forms part of a series of medals commemorating anniversaries of eminent persons (scientists, artists etc.) and aimed at promoting wider international understanding of their contribution to the progress of mankind and at recognizing outstanding achievements in one of UNESCO's fields of competence.

Prof. Rao a recipient of Padma Shri and Padma Vibhushan is a well-known researcher in the field of solid state chemistry, surface phenomena, spectroscopy and molecular structure, will receive a diploma and an Einstein medal.

Author of over 700 research papers and 30 books, Prof. Rao obtained his Ph.D. from Purdue and D.Sc. from Mysore. He is a Fellow of several prestigious science academies and the recipient of numerous medals and awards. ❑

DSRM

Journal of Scientific & Industrial Research
(Incorporating *Research and Industry*)
Instructions to Contributors

The **Journal of Scientific & Industrial Research** (Incorporating ***Research and Industry***) is published monthly to serve as an information link between the generators and users of technologies. It is addressed primarily to industrial entrepreneurs, technologists, engineers, technocrats and administrators in industry. Therefore, original research articles of practical interest to industry are invited for publication.

Contributions should have an economic bias, and wherever possible, cost estimates should be provided. They should be tersely written, giving only the significant results.

Besides, reviews on various branches of science and technology, science/industrial policy and management are also accepted.

Subject Coverage

Scientific Industrial Research

(i)Scientific investigations successful at the pilot-plant and in-plant trials.

(ii)Technology upgradation.

(iii)Development of cheaper and indigenous raw materials as replacement for uneconomical materials.

(iiv)Import substitution.

(v)Technologies for rural development.

(vi)Standardization and quality control.

(vii)Technologies of waste management.

(viii) Industrial R&D highlights.

Technology Management

(i)Success/failure stories in technology management.

(ii)Technology assessment.

(iii)Technology transfer.

(iv)Technology assimilation and adaption in different industries.

(v)Technology funding including venture capital.

(vi)Human Resource Development.

vii)Management.

(viii) Environmental management.

Industrial Development

(i)Policies, programmes and progress.

(ii)Critical profiles of industries—individual and sectoral.

(iii)Technology Forecasting .

(iv)International Collaboration.

(v)Fiscal incentives aimed at industrial development.

Books, monographs and technical bulletins on industrial methods and techniques as well as other data like production and demand statistics are accepted for review.

A critical analysis of papers presented at any Indian as well as international technology seminar/ symposium is also welcome.

Questions on the articles published in the journal, answers supplementing any of the published items, views, opinions, or suggestions on the various aspects of technology are welcome for inclusion in the column, 'readers react'.

The editors are keen in projecting the technology bottlenecks/problems faced by the industry for their solution by the scientists in various laboratories. They would welcome to be mediators between the industry and the laboratory.

Preparation of Manuscript

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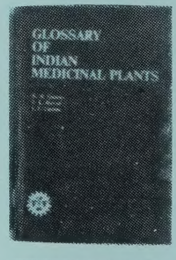

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